Supporting self-supply

An innovative approach to reach SDG6.1 in rural Africa at $25/person

Context

The recent report "State of the World's Drinking Water" calls for urgent action to accelerate progress on ensuring safe drinking water for all, among others in Sub Saharan Africa (SSA) (WHO, 2022). One such action can be scaling up the SMART approach. SMART stands for Simple, Market-based, Affordable, and Repairable Technologies and examples include household water filters, manually drilled tube wells, locally produced hand and solar pumps, rainwater harvesting and underground storage tanks. The local production of technologies can reduce the investment cost (CapEx) of an improved water source to as low as $25/person, provided the annual rainfall is >200mm. This is 2 to 6 times lower than the CapEx/person with imported technologies for larger rural communal wells (Sutton, 2021). A large part of the SDG 6.1 target group in rural SSA could be reached with this approach and at the same time lift rural families out of extreme poverty. The SMART approach includes:

1. **Innovation**. New technologies for wells, pumps, etc. that can be produced locally.
2. **Training**. Building capacity of the local private sector in technical & business skills
3. **Self-supply**. Stimulate households to invest in their own well. For instance, subsidizing farm wells that are used for both domestic and productive uses like irrigation instead of subsidizing communal wells which are just for domestic use.

SMARTechs are disseminated in nine African countries via SMART Centres who train the local private sector. The objective of this paper is to share evidence how "*the SMART approach is contributing to SDG6 but also to SDGs for poverty alleviation, food security, gender equality, employment and climate resilience".* That evidence is based on the book "Self-supply, the evaluation of this approach by IRC (IRC, 2022) and on decades of field experience.

Technological innovation

SMARTechs are low cost due to innovations that made technologies simpler, more effective and fit for local production. Technologies promoted by SMART Centres include:
<u>Household Water Treatment</u>; Where people do not have safe drinking water an intermediate solution promoted by the WHO and UNICEF is Household Water Treatment and Safe Storage (HWTS). Especially household water filters are effective and can provide safe drinking water at an investment cost starting at $4/ person.
<u>Wells</u>; By using PVC casings with a diameter of 5 cm the cost of hand drilled tube wells can be as low as $10-$15/metre so a well of 30 meter deep costs $300 - $450 including a pump. Tube wells with a larger diameters cost $500 - $1200 including a rope or small solar pump. Improved manual drilling technologies that can be produced locally can now also drill in medium hard ground layers. For areas with rocks small mechanical drills can be used.
<u>Pumps;</u> Handpumps that can be produced in any country in Africa include EMAS, rope and Pitcher pumps that cost $50 - $120. (Sutton, 2021). New small solar pumps with similar pump capacity as hand pumps can be locally assembled and cost $150 to $500.
<u>Rainwater harvesting and storage;</u> In general handpumps do not pose a risk to deplete groundwater but to avoid that risk to a maximum the SMART centres promote "the water balance" and Managed Aquifer Recharge (MAR). Examples of household level MAR include "the Tube recharge" that can store 100 - 200 cubic meters/year and cost $20. Other options to harvest rain are "contour bunds" or "Deep Bed Farming". Where low cost wells are not possible, rain can be stored in underground tanks of 7000 litres that cost $150-$200 including a pump. More info on innovative technologies in Annex 2.

Training

After due training the technologies mentioned before can be produced in any country. Early examples are the EMAS pump in Bolivia and the rope pump in Nicaragua. Both started

around 1990 and over 70,000 of each pump type were installed in these countries. In Africa the introduction of SMARTechs started around 2000.
Although technologies like an EMAS drill or a rope pump are simple, the hard lesson learned is "Simple is not easy". Good quality technologies and services require long term training and coaching in both technical and business skills. See also Annex 2 and 3.

Self-supply, farm wells
Self-supply is when households partly or completely fund their own water supply.
Some examples:
USA. Over 45 million hand pumps were installed on farm wells that often were made with manual drilling tools. Farmers climbed "the water ladder" and replaced the hand pump with an electric pump. Many are now connected to piped systems but still 18 million farmers in the USA and Canada have self-supply due to the high cost of piped systems in rural areas.
Asia. Over 500 million people in this region have self-supply, so more families have their own supply than supply by utilities, and 96% use an improved groundwater source (Foster, 2022).
Latin America. Over 70% of the EMAS wells in Bolivia were paid by families. In Nicaragua a small part of the 70.000 rope pumps were installed on subsidized boreholes for rural communal supply, but a large part on hand dug wells of farmers who paid themselves (full self-supply). Some NGOs donated a pump to families who invested themselves in a well (supported self-supply). Results were improved water quality but also an economic impact. An extensive study indicated that replacing the rope and bucket by a pump increased family incomes by on average $225/year. So the total increased family incomes over 20 years was > $100 million. This was a result of $2 million aid funding (RWSN, 2022).
Africa. The Water Aid organisation in Zimbabwe supported families with materials to upgrade wells that families dug themselves, with a well cover and windlass. Later on government also supported and now there are > 200.000 improved family wells. In Nigeria some 90% of the water supply in Lagos is self-supply so families pay a well driller to drill a tube well (Danert, 2015). In Madagascar over 150,000 Pitcher pumps are installed. In Sierra Leone there are 3000 EMAS wells and this technology starts in other African countries. Between 50% and 80% of all wells / pumps mentioned above were paid for by families so self-supply. These and many other examples are described in the book "*Self-supply" - Filling the gaps in public water supply provision"* (Sutton, 2021). See also Annex 4

Conclusions

1. In rural areas with a yearly rainfall of > 200mm, SDG 6.1 can be reached at an average investment cost of $25/ person by using the SMART approach. This is 2 - 6 times less than the cost to reach SDG 6.1 with the conventional approach.
2. The SMART approach to reach SDG 6.1 in SSA implies a transformation from:
   - importing technologies to also produce technologies locally
   - water for domestic use only to also water for productive use
   - subsidizing communal water supply to also subsidize household wells.
3. Upscaling merely requires dissemination of knowledge on these innovations and large scale training programs of the local private sector.

Reach SDG 6.1 in rural SSA by subsidizing farm wells and storage tanks
At several water fora professor John Cherry, recipient of the 2020 Stockholm Water Prize, highlighted the need for tens of millions of small wells in SSA especially for food production (Cherry, 2022). Millions of new wells may raise concerns like depletion of ground water and water quality for drinking. These concerns can be effectively addressed. See Annex 1 and 4. Some 400 million people in SSA do not have "safely managed" or "basic water service", the target group of SDG 6.1. Some 80%, so 320 million people, live in rural areas and are mostly small holder farmers with plots of 0.5 to 5 Ha. Many of these farm households live in areas where it is possible to drill low-cost tube wells. Where wells are too expensive underground tanks combined with water filters are an option. The average cost to provide water with

"new" locally produced technologies is 25$/ person so, **the cost to reach SDG 6.1 in rural SSA would be 320 x $25 = $ 8 billion.**
This is 2 to 6 times less than what would be needed with imported technologies (Sutton, 2021) or what would be needed according to the WHO (WHO, 2022).

Besides reaching SDG 6.1 other advantages of this approach include contributions to;

- SDG 1. Poverty alleviation. Water for livestock and irrigation can generate income
- SDG 2. Food security. Families with a well can also grow food in dry periods and are less vulnerable for dry spells.
- SDG 3. Gender. A household well reduces the time now used to collect water.
- SDG 8. Employment. Drilling wells and producing pumps create jobs for drillers and metal workers. Access to water on farms creates work in agriculture.
- SDG 13. Climate. Rain water storage and low-cost wells build climate resilience.

Once-off subsidization of farm wells to reach SDG 6.1 is already happening in Zambia. Subsidizing farm wells creates sustainable rural water supply, including a solution to the eternal maintenance challenge of communal pumps. It can create a commercial supply chain of affordable technologies for 100% self-supply. See Annex 4.

Regarding funding: in general the people in SSA who already have "safely managed" or "basic service" through piped systems or hand pumps were subsidized by Governments or aid organizations with at least $25 / person for the CapEx. Similar subsidies, totalling $8 billion, would reach 320 million people in rural SSA, a target group of SDG 6.1 that is "left behind".

References

- Cherry. J. Key note speech at the 2022 Stockholm Water Week. https://www.youtube.com/watch?v=O_Qgfgg5XhU
- Danert.,K. 2015. Manually Drilled Boreholes. Providing water in Nigeria's Megacity of Lagos and beyond Drilling sector in Nigeria. https://www.rural-water-supply.net/en/resources/details/653
- Foster, T. UN groundwater conference, December 2022. Paris.
- IRC. 2022. The assessment of the Simple, Market-based, Affordable, Repairable, Technology (SMART)approach for water and sanitation https://www.rural-water-supply.net/en/resources/details/1081
- Sutton, S. 2021 "Self-supply" https://practicalactionpublishing.com/book/2530/self-supply
- WHO, UNICEF, World Bank Group 2022 https://www.who.int/publications/i/item/9789240060807
- UN. 2022. The UN World development report. 2022, Groundwater Making the invisible visible https://www.unwater.org/publications/un-world-water-development-report-2022
- Information on technologies fit for self-supply/ farm water systems; https://smartcentregroup.com/wp-content/uploads/2018/02/SMARTech-Catalogue.pdf

Websites

Tiyeni - https://www.tiyeni.org, https://www.tiyeni.org/research
MetaMeta - SMART Centre Group www.smartcentregroup.com
SMART Centre Zambia. www.smartcentrezambia.com
SMART Centre Tanzania. www.smartcentretanzania.or.tz
The groundwater project. https://gw-project.org/

Authors:
Henk Holtslag, Reinier Veldman. MetaMeta - SMART Centre Group.
John Cherry. Recipient of the 2020 Stockholm Water Prize. Leader of The Groundwater Project
Barbara van Koppen. International Water Management Institute (IWMI)
Colin Andrews. Chair of Tiyeni

Version 17-01-2023

Annex 1. Reach SDG 6.1 in rural SSA by subsidizing farm wells and storage tanks

"The state of the World's Drinking Water" report indicates that the investment needed to reach SDG 6.1 by 2030 and providing 50% with safely managed drinking water and 50% with basic service is over $600 billion (WHO,2022). Over 400 million people of this target group live in SSA of which 80% are rural, often in areas with less than 50 people per square km.

Basic service (an improved water source at less than 30 minutes walking from home) with conventional technologies like a machine drilled borehole and an imported pump in these areas would cost $50 - $150/person (Sutton, 2021).

With the SMART approach as used in Zambia the SDG 6.1 target group in rural areas with a low density population can be reached. Where manual drilling is possible a $1000 well and pump can serve 40 people so the CapEx is $25/ person. Where manual drilling is not possible, underground tanks can be made with a similar cost per capita.

With regard to funding, in general every person who already has "safely managed" or "basic service" received a Government or NGO subsidy of $25 or more for CapEx. The 320 million people in rural SSA who not yet have safely managed or a basic service, deserve to receive the same subsidy. The cost to reach 320 million people with the SMART approach would be $8 billion which should be funded by governments, NGOs or others funding and development agencies interested in reaching SDG6.1; so interested in "leaving no one behind".

Recommendations

Actions to scale rainwater harvesting and farm wells include;

1. Wide scale awareness creation and training

Raise awareness, train and develop capacity of manufacturing and dissemination of existing and new low-cost technologies for rainwater harvesting, wells, pumps etc. but also on sustainable agriculture practices. This could be done via "Rural development hubs" in each country. Examples are WET Centres of CAWST or the SMART Centres of MetaMeta.

2. Build supply chains of affordable technologies

Build up commercial supply chains of effective, attractive and affordable water, sanitation and agriculture products. Outlets in each town should sell a range of options so people can choose. Large scale programs are needed to train the local private sector (SMEs) in technical and business skills.

3. Innovate payment systems

Payments options for those who cannot pay in one time like Micro credit, Pay as you go, etc.

4. Subsidies for the target group of SDG 6.1

Subsidies for farm wells that provide water for domestic use for small groups of people and at the same time produce food as for example is happening in Zambia.

References:

- Sutton. S. 2021. "Self-supply" https://practicalactionpublishing.com/book/2530/self-supply

Websites

- SMART Centre Zambia. Jacana www.smartcenterzambia.com
- SMART Centre Tanzania. SHIPO www.smartcentretanzania.or.tz

Annex 2. Innovation.

Examples of SMARTechs, so innovative, market-based and affordable technologies include:

HWTS/ <u>Household water filters</u>;
Worldwide over 2 billion people do not yet have safe drinking water. (WHO, 2022). Probably the most cost-effective, be it intermediate, solution is Household Water Treatment and Safe storage (HWTS) so Point of Use Treatment as promoted by the WHO, UNICEF and members of HWTS network coordinated by the Centre of Affordable Water and Sanitation Technologies (CAWST). Of the options like filters, chlorine and boiling, filters are very effective in reducing water borne diseases due to a consistent use (Wolf, 2018). There is a wide range of household water filters including options that can be produced locally like the ceramic pot filter and bio sand filters. Tabletop filters with a "hi tech" diatom filter element can treat 30 to 60 litres per day and cost $25 - $40. Filters with a membrane filter element can treat 100 - 200 litres per day and cost $50 - $100. These filters remove biological contamination and are common in Asia but not yet in Africa. Where chemicals like arsenic are a problem, rainwater can be stored just for drinking and treated with a filter. Cost of water filters can be reduced by importing a high quality filter element and producing the containers locally. In Ethiopia over 350.000 filters were already produced this way. An interesting development in Ethiopia is that an increasing number of utilities see that they cannot always deliver safe drinking water, among others due to power cuts, so start selling filters as an additional service (Foppen, 2019). In many countries in SSA water from (old) piped systems is not always safe to drink so Ethiopia could become an example for other countries.
Regarding safe drinking water with HWTS: a bold idea called "2 with 8" was launched at the Stockholm World Water Week 2022 by a small group of people including John Cherry. It states that safe drinking water for 2 billion people would be possible with a donor investment of "just" $8 billion. This $8 billion would be needed for awareness raising, building a commercial supply chain with voucher systems, and subsidies for the poorest. (MetaMeta, 2022).

<u>Upgrading hand dug wells</u>
In SSA there are an estimated 5 to 9 million hand dug wells made and funded by families themselves. Many of these wells are open and water is lifted with a rope and bucket which is often a cause of contamination. These wells could be upgraded with a well cover and a locally produced hand pump like EMAS, rope or Pitcher pump so become an improved water source (Sutton, 2021). Also many hand dug wells dry up in the dry season and making wells deeper can be dangerous due to collapsing or it may not be possible due to rocks. To avoid wells drying up an option is to install a "Tube recharge system" near the well. Such system collects rain from the roof or the ground in a small pit and water infiltrates in the ground via a cloth and sand filter. After training these systems can be made by families themselves. The cost of materials like a PVC pipe and cloth filter is around $20 (Jacana, 2022). For information on these technologies, see websites of SMART Centre Zambia and the SMART Centre Group.

<u>Hand drilled tube wells</u>
Most boreholes for communal rural water supply in Africa are drilled with imported drilling rigs and are combined with an imported handpump and increasingly a solar pump. Boreholes with hand pumps are often between 30 and 60 metres deep and normally used by 250 people. They cost $2500 to $7500. Drilling rigs with "down the hole hammer" or other technology are very effective to drill in rocks but also are complicated and costly. In areas without rocks, smaller boreholes (tube wells) can also be drilled with simpler and locally produced drilling tools. For example, EMAS or SHIPO drill sets cost $600 to $1200. For the same well depth, manual drilled wells can have the same pump capacity and water quality as machine drilled boreholes (Practica/UNICEF, 2010). The cost of an EMAS well can be so low since it uses very small casing diameters so a well of 30 meter deep costs $300 - $450 including a pump.
The EMAS drill can go to 60 m deep or more. The cost of a larger SHIPO drilled tube well (similar to rotary jetting) of 30 m deep is $800 - $1200 including a rope pump or solar pump.

The SHIPO drill can make wells to 45 m deep (IRC, 2022). Options that can drill to 25 metre deep include the Mzuzu drill. All these options can drill in medium to hard ground layers but not in rock. For drilling in rock, small mechanical drill sets can be used like Shaw or Deep rock drill. Information on manual drilling is at websites of RWSN, Jacana, SMART Centre Group.

Pumps

Imported hand pumps like the Indian Mark II and Afridev on wells to 40 m deep cost $ 600 - $1000/pump. Locally produced pumps like EMAS or rope pumps that can pump from wells of 40 metres deep cost $50 - $120. These pumps are fit for 50 people and also affordable for families. A new development are small solar pumps that can be assembled locally. They have similar pump capacities as hand pumps and depending on size and depth they cost $150 - $500. After testing for several years by SMART Centres they are now starting to be disseminated. The local production of EMAS, rope and solar pumps reduces the need for foreign currency and guarantees that skills and low cost spare parts for repairs are locally available. This is key for maintenance.

Communal wells in rural areas in SSA provide “basic service” (an improved source at less than 30 minutes collection time) and are for domestic use so for drinking, cooking and hygiene. A reason that more than 25% of these pumps are not functioning is the lack of funds for larger repairs. By installing pumps at premises of rural farm households, water will also be used to produce food for own consumption and a surplus that can be sold in the local market and so generate some income to pay for repairs. Information on hand pumps at the website of the World Bank (The hand pump option), RWSN and SMART Centre Group.

Rain water harvesting and storage

Groundwater can supply water year-round. However, depletion of groundwater should be avoided. Over-draft happened in some parts of India as a result of large scale pumping water for irrigation even from deep water layers. Hence, where wells are promoted there should be awareness on the ”water balance”. No more water should be pumped out than somewhere goes in (renewable groundwater). There are a range of Managed Aquifer Recharge (MAR) options. Examples fit for households and farmers include the Tube recharge that can recharge 100 to 200 cubic meters per year. Part of this water stays near the well and so can be pumped up in the dry season. After training these systems can be made by farmers themselves at a cost of $20 for materials. Other options include contour bunds or collecting water from roads. Where drilling wells by hand is too expensive or water levels are too deep, an alternative with a similar cost per capita are EMAS underground tanks. These contain 7000 litres and cost $150-$200 including an EMAS pump.

Deep Bed Farming (DBF) Malawi

A promising and proven option for rain water harvesting is DBF that is applied in Malawi. Over 70% of all people in this country are smallholder farmers with plots of 0.5 to 5 Ha. Most farm work is done manually and crops are rainfed. This makes families and especially women, highly vulnerable to climate change shocks such as drought, dry-spells and flooding. Maize, a key staple crop, is particularly vulnerable, with up to a 40% yield decline anticipated with warming of 2°C (IPCC, 2022). Inconsistent rainfall combined with conventional farming are leading to top-soil erosion. In Malawi it is common practice that the waste of crops like maize or groundnut is burned and that the land is left barren until the next growing season. This contributes to soil erosion during rains and the generation of a “hardpan” in dry periods.

Hardpan, “discovered” by the FAO in 1997, is common in some areas in Malawi and other countries (FAO. 2019). The hardpan is a layer of 20 cm – 30 cm situated under the topsoil. It prevents the infiltration of rainwater, hindering root development and plant growth. It also prevents the recharging of shallow aquifers. To address this challenge the UK and Malawi-based organization, Tiyeni, developed the DBF method which consists of a one-time tillage combined with furrows and flat-topped beds along the contour which promote high levels of infiltration.

Crop stalks and leaves become mulch, so a layer that retains water and deposits nutrients in the ground. DBF also incorporates crop rotation with legumes, interplanting of crops between the beds, and "green manure cover crops". for irrigation.
The combination of DBF with conservation farming, can increase yields from the current 2 tonnes/Ha to 4 tonnes or more /Ha with 1 harvest per year (Mvula, 2021). DBF is currently practiced by 30,000 farmers and was adopted by the Malawi Government as part of its development strategy (Tiyeni, 2022). Whether using DBF or other water harvesting options, the challenge in all areas is to ensure that rain percolates into the ground as much as possible.

An example of rain water harvesting on 0.5Ha (5000 square meters)
With a yearly rain fall of 500 mm the volume of rainwater on 0.5Ha is 2500 cubic meters per year. Assuming that there is no run off and 1500 cubic meters is "used up" by a rainfed crop and evaporation, some 1000 cubic meters is infiltrating deeper in the ground. Then in theory 1000 : 365 = 2.8 cubic meters/day (2800 litres) can be pumped up without depleting the ground water, assuming that neighbours also avoid run off and infiltrate all rainwater. If there is a well on this plot that serves 40 people with 25 litres/day for domestic use, there is 1800 litres/day left for productive uses. Of the 0.5Ha, some 1000 square meters could be used to irrigate cash crops and 4000 square meters could be used to grow rainfed maize. Of the yearly maize production of 3 tonnes or more, 1.5 tonnes could be used to feed the family. The remaining part could be sold (around $0.5/kg) or be used to feed chickens. This example illustrates farmers can avoid run off of water with options like contour bunds, DBF or other technologies, there is enough water for small scale productive uses even in areas with just 500 mm of rain. Where yearly rainfall is more than 500mm, more water is available for productive uses.

References

- FAO 2019. https://agris.fao.org/agris-search/search.do?recordID=US202000089856
- Foppen, H. 2019 https://www.ircwash.org/sites/default/files/084-201906foppenholtslagchekoltheutilityappr_002.pdf
- IRC, 2022. The assessment of the Simple, Market-based, Affordable, Repairable, Technology (SMART)approach for water and sanitation https://www.rural-water-supply.net/en/resources/details/1081
- IPPC. 2022. https://www.ipcc.ch/report/ar6/wg2/
- Jacana. The tube recharge https://jacana.help/resources/water/
- Jacana. 2022. Drillability map made by Practica, UNICEF. See www.smartcentrezambia.com
- Mvula, A. & Dixon, A. 2021. Farmer experiences of Tiyeni's 'deep-bed farming' conservation agriculture system in Malawi. Agroecology and Sustainable Food Systems 45(2), 175-196. https://www.tiyeni.org/facts-and-figures
- MetaMeta SMART Centre Group. 2022. https://smartcentregroup.com/index.php/2022/09/27/launching-the-2-with-8-initiative/
- Practica and UNICEF. 2010. https://www.rural-water-supply.net/en/resources/details/916.
- Sutton, S. 2021. "Self-supply" https://practicalactionpublishing.com/book/2530/self-supply
- RWSN. 2022. https://www.rural-water-supply.net/en/resources/details/1071
- RWSN. 2009. https://www.rural-water-supply.net/en/resources/details/171
- UN. 2022. The UN World development report. 2022, Groundwater Making the invisible visible https://www.unwater.org/publications/un-world-water-development-report-2022
- WHO, UNICEF, WorldBank. 2022. https://www.who.int/publications/i/item/9789240060807
- Wolf, J, Clasen,T. Bartram, J. et al. 2018. Impact of drinking water, sanitation and handwashing with soap on childhood diarrhoeal disease: updated meta-analysis and meta-regression. https://pubmed.ncbi.nlm.nih.gov/29537671/

Websites

- CAWST .2021. Info on HWTS products; https://www.hwts.info/products-technologies).
- MetaMeta SMART Centre Group.Information on technologies fit for self-supply/ farm water systems; https://smartcentregroup.com/wp-content/uploads/2018/02/SMARTech-Catalogue.pdf
- SMART Centre Zambia. www.smartcenterzambia.com
- SMART Centre Tanzania. www.smartcentretanzania.or.tz
- SMART Centre Nicaragua. www.smartcentrenicaragua.com
- Tiyeni organisation. www.tiyeni.org
- WHO. HWTS info https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/water-safety-and-quality/household-water-treatment-and-safe-storage

Annex 3. Training

In a key note speech at the Stockholm Water Week in 2017, Ger Bergkamp, former Executive Director of the International Water Association (IWA) mentioned that “to reach SDG 6, over 3 million practitioners would be needed. Training all these people would require a “Marshall plan”-type of capacity building”. There is a lack of engineers who can design new water systems, control the quality of newly drilled boreholes or repair pumps. Thousands of well diggers who now dig wells by hand could be trained in new manual drilling technologies that make work safer and would reduce the cost of wells. There is a lack of metal workers who know how to produce well drilling tools and handpumps and technicians who know how to select and install solar pumps. In short there is a huge need to build local capacity in a wide range of skills. Trainings could be realised in WASH training centres with training capacity and demonstration of all technologies that are relevant. Centres where staff from Government, NGOs, and companies and farmers can see working examples and get advice on the most cost-effective options for the local context. Examples of such training centres are the EMAS centre in Bolivia and Sierra Leone and SMART Centres in Africa.

Other organizations working in this field include the Practica foundation which, with the support of UNICEF, has developed the manual well drilling sector in Chad and other countries. Practica also developed “drillability maps”. An example is a map for Zambia that indicates which areas are suitable for manual drilling. The EMAS group trained many well drillers in Latin America, Sierra Leone, and Senegal. In Zambia, Malawi and Kenya they trained in technologies fit for self-supply in cooperation with the SMART Centres there. The MetaMeta SMART Centre Group works with SMART Centres in nine countries in Africa and one in Nicaragua. Via training an estimated 10 million rural people in SSA got access to water with manual drilled tube wells/ boreholes and/or locally produced handpumps. Worldwide, some 130,000 rope pumps are installed on subsidized wells for small communities and increasingly for self-supply (Haanen, 2017). Although the rope pump is simple, a lesson learned is; “Simple is not easy”. It takes 2 to 3 years of coaching of local pump producers to make sure they produce good quality pumps. The same is true for well drillers. Besides the training of drillers and pump producers in technical aspects, it is also essential to train them in business skills to make sure the company is financially sustainable and can go on after training without or with only minimal subsidies. South-South exchange of knowledge on technologies and lessons learned including failures are essential to reach water related SDGs. For information on EMAS and SMART Centres see websites.

References

- EMAS Technologies ; https://tadeh.org/en/
- Haanen 2017. https://smartcentregroup.com/wp-content/uploads/2017/06/RWSN-130.000-Rope- pumps.-R.H.-Paper.pdf

Annex 4. Self-supply.

Farm wells are key for rural development. Farm wells created with household funds (self-supply) was essential for rural development in the USA. Millions of hand pumps were installed on hand dug wells with a diameter of 80 to 120 cm or tube wells (boreholes) with a casing diameter of 6 to 15 cm. Tube wells were made with manual drilling tools or mechanized drilling rigs. Farmers climbed "the water ladder" and replaced the handpump with a windmill or electric pump and now many are connected to piped water systems (Sutton, 2021; Cherry, 2022). In some areas in the USA the cost for piped systems to individual plots is too high so many rural families still have self-supply, so a tube well for domestic use paid by themselves. Even if farmers are connected to a piped system, they often still have wells for productive uses like cattle watering or irrigation. In rural areas of Asia-Pacific more than 500 million people have self-supply, 96% of whom use an improved groundwater source (Foster, 2022). Although the geology and other aspects in Sub Saharan Africa are different, the logic is the same: *A farm family can only develop with water at premises!*

Concerns about self-supply
The idea of millions new farm wells can raise concerns like;

1. **Depletion of water layers**
   What will happen if all farmers in SSA will have their own well? Will groundwater layers (aquifers) not be depleted?
2. **Water quality.**
   Is water from farm wells safe to drink?
3. **High cost**
   Is the investment cost/person (CapEx) of a tube well for 40 people not more expensive than a borehole for 250 people?

<u>Regarding 1</u>. Hand pumps or small solar pumps in general do not pump more than 1 to 5 cubic meters per day so typically have less risk of depleting ground water than large irrigation pumps. Programs for farm wells should include awareness around "the water balance", so no more water can be pumped out than somewhere goes in. Also wells should be combined with rainwater harvesting.
<u>Regarding 2.</u> In general, water from tube wells of 15 to 30 m deep is safe to drink. Tube wells can be drilled with a similar quality as larger boreholes so with good hygienic seals.
In case of doubt, the 2-5 litres/person/ day for drinking can be made safe with Chlorine, boiling or a household water filter. In case of chemicals like arsenic or fluoride, an option is to store for instance 1000 litres of rainwater, treat it and use that for drinking.
<u>Regarding 3.</u> Small diameter tube wells and locally produced pumps can be 2 to 6 times cheaper than larger machine drilled boreholes and imported pumps for the same depth. Cost of tube wells and pumps of 30 m deep made with innovative technologies range from $300 - $1200. Based on experience in Zambia, manual drilling like jetting, sludging and auguring is possible in a large part of the areas in SSA where people live (Jacana, 2022). For areas with rocks small mechanical drills can be used.

Communal wells with import technology versus household wells with local technology
The conventional approach for rural water supply in SSA is a machine drilled borehole with an imported hand pump used by an average of 250 people, costing $2500 to $7500. The CapEx (investment cost of borehole and pump) is $10-$30/ person which is usually funded by government or donated by an NGO. To comply with the SDG 6.1 indicator for "basic service" people need to have an improved water source at less than 30 minutes return trip (so less than 1 km distance) from home. However, in many countries in SSA the number of people per square kilometre is less than 50. Reaching rural communities with less than 250 people and with the conventional technologies would cost $50-$150/ person (Sutton, 2021).

This high cost per person is a reason why governments or NGOs hardly invest in water supply systems for small groups of people.

A solution is to use another approach. A tube well for a few families does not need a high yielding aquifer but can also function with “intermittent yield”. For instance, a casing with a diameter of 6 cm has a storage capacity of 30 litres per meter so with 5 meters of water level, the storage is 150 litres. Pumping 6 times per day yields 900 litres which is enough for domestic use of 40 people. Between each pumping out, groundwater can slowly flow into the borehole casing. Compared to communal wells, household wells have advantages like:

- High functionality of pumps.
  Experience in Zambia and other countries is that 95% of family-owned pumps are functioning, which can be explained by the clear ownership, the convenience, the food production and the extra income, so funds for repairs (IRC, 2022).
- Time saving and safety for women and girls.
  A well at or near premises saves time and increases safety for women and girls who now collect water from distant communal wells or other sources
- Food security and income.
  Having water at premises all year round stimulates the production of food and sales of surplus to local markets.

Besides the impact on SDGs on poverty alleviation, food security, access to water and gender equality, farm wells create employment for well drillers and metal workers and irrigation gives work for farm families. Wells combined with rainwater harvesting, builds resilience to climate change.

Examples of supported self-supply:

Zambia. Drillers trained by the Jacana SMART Centre in Chipata drilled over 400 tube wells with the SHIPO drill in East Zambia mostly in areas where families did not yet have a basic water service. The well and rope pump (cost $1000 excl. cost of overhead) was 90% subsidized. The condition for the subsidy is that the families generate income with the water. The experience is that families with a well share water for domestic use with an average of 40 other people, so family owned wells serve small communities (IRC, 2022). The family with the well also uses the water for irrigation or other income generating activities. The experience is that over 95% of the family owned pumps are functioning. (The functionality of imported pumps on communal boreholes in this area is around 70%.) The high functionality of family owned pumps is explained by the clear ownership, the convenience and the extra income which provides money for maintenance. Another reason is that the pumps, in this case rope pumps, are affordable and produced locally, so spares and skills are available. Women and girls in particular benefit from water at or near premises since they are the ones who collect water from distant communal wells. Another effect of these subsidized wells was the creation of a market for self-supply. Already over 130 families paid for wells and/or pumps 100% themselves. The creation of a market for 100% self-supply also happened in Tanzania and Malawi.

Tanzania

Around 2005, the SMART Centre in Tanzania installed some 700 rope pumps on manual drilled wells in small communities and schools with 90% subsidy. The result is that in 2021 there were more than 15.000 rope pumps installed on both manually drilled tube wells and hand dug wells in peri urban and rural areas of which over 70% is full self-supply. Many of the some 100 well drillers and pump producers that were trained by the organisation Southern Highland Participatory Organisation (SHIPO), are now independent small companies who went on after the training and sell their products to local government, NGOs, and families so there is a “profit based sustainability” (IRC, 2022).

Nicaragua
Another example is Nicaragua where the rope pump was introduced around 1990. With development aid local companies were trained to produce this pump and by the year 2010 there were over 70.000 pumps installed. With the increasing access to electricity in rural areas many families replaced the rope pump by an electric pump (climbing the water ladder), but even now there still are some 50.000 rope pumps functioning (RWSN 2022). Part of the rope pumps were subsidized especially for rural communal boreholes. Some NGOs donated a pump to rural families if that family would invest themselves in a well (supported self-supply). However, a large part of these pumps are paid for by families/ farmers themselves.
Besides improved health there was an economic impact. An extensive study indicated that families who replaced the rope and bucket on their wells by a rope pump increased family income by an average of $225 /year. (Alberts and Van Der Zee, 2003). The total increased incomes of all farmers with a rope pump over 20 years was over $100 million. This development started with the investment of $2 million development aid for training and coaching of pump producers (RWSN, 2022; Briemberg, 2022).

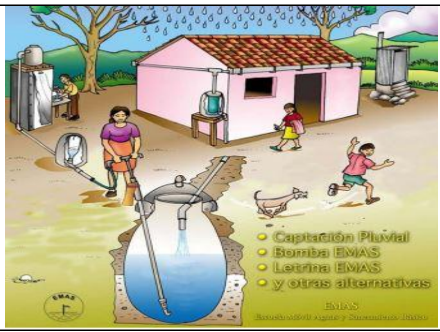
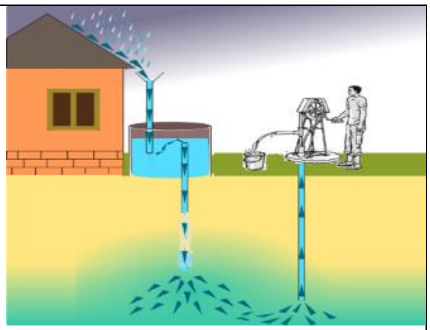
References

- Alberts, J.H. and v. d. Zee, J.J. 2003. 'A multi sectoral approach to sustainable rural water supply in Nicaragua. Role of the rope handpump" https://www.musgroup.net/sites/default/files/phpLPMx9N.pdf
- Briemberg, J. 2022. The SMART approach. The case of the Rope Pump in Nicaragua. https://smartcentregroup.com/wp-content/uploads/2022/07/The-SMART-Approach-The-Case-of-the-Rope-Pump-in-Nicaragua-FINAL-2022.07.06.pdf
- Cherry, J. Key note speech at the 2022 Stockholm Water Week. https://www.youtube.com/watch?v=O_Qgfgg5XhU
- IRC. 2022. The assessment of the Simple, Market-based, Affordable, Repairable, Technology (SMART)approach for water and sanitation https://www.rural-water-supply.net/en/resources/details/1081
- RWSN. 2022. https://www.rural-water-supply.net/en/resources/details/1071
- Sutton, S. 2021. "Self-supply" https://practicalactionpublishing.com/book/2530/self-supply

Websites

- SMART Centre Zambia. Jacana www.smartcenterzambia.com
- SMART Centre Tanzania. SHIPO www.smartcentretanzania.or.tz
- SMART Centre Nicaragua. www.smartcentrenicaragua.com

Annex 5. Pictures of technologies fit for self-supply

		
Wire brick cement tanks Material: wire, bricks, cement. Volumes 1 to 50 Cubic metre Cost material: $20-$40/ c.metre	**EMAS underground tank** Egg shape hole of 7000 litres plastered with cement. Cost material: $100 -$ 200	**Tube recharge** Prevents dry wells. Can recharge 100-200 cubic meters /yr. Cost material: $10 - $50
		
Water from open wells Can be improved with a well cover and hand pump.	**Well cover & hand pump** Cost material: $100 - $200	**Tube bailer** Technology to deepen existing wells. Cost material: $20 -$100
		
Mzuzu manual drilling Soft, medium hard geology. Casings: 1.5 - 4 inch. Depth: 5- 25 metre	**EMAS manual drilling** Soft geology. Casings: 1.5 - 3 Inch Depth: 10- 60 metre. Cost: $10- $15/ metre	**SHIPO manual drilling** Soft, medium hard geology. Casings: 1.5- 4 inch Depth: 0-50 m. Cost/well: $400 - $1000

		
EMAS pump Pump depth: max 40 m. Can pump up to 30m high. Cost/pump: $ 40-80	**Rope pump 4 models** Models for hand dug and hand drilled wells. Cost/pump: $ 60 – 120	**Solar pumps 12-24 VDC** Pump head: 5 - 30 m Pump volume: 15 - 5 l/min Cost pump+panel: $100 – 300
		
Table top filter. Diatom elem. Options like Nazava, Tulip. Cost: $20 - $40	**Table top filter, membrane element** Aqua clara Cost; $30- $50	**Membrane filter** Options like Sawyer Cost: $25 - $40
		
Latrines Corbelled latrines. SaTo pan latrines several models Cost of plastic part $10 - $40	**Irrigation of cash crops.** Here 1000 m2, irrigated by 1 family with a Rope pump. Yearly extra income: $ 100 – $1000	**Simple is not easy**. SMART Centres training the local private sector and building supply chains.

Info on other options for affordable water and sanitation see EMAS websites or the SMARTech catalogue; www.smartcentregroup.com. Examples of scaling self-supply see www.smartcentrezambia.com