SPATE IN GASH BARKA
Findings from the Field

Ministry of Agriculture
and SOS Faim

Ian McAllister Anderson for SOS Faim
ianmcanderson@aol.com
What is the role of spate irrigation in Gash Barka?

- Two types of system
  (i) takes water from local catchment (4-6 km²)
  (ii) takes water from the larger catchment (15-80 km²)
- Sorghum needs about 450 mm for good production
- Considering 2010 - regarded as good rainfall year
  => shortage of ~ 200 mm since storms are very intense
  => higher runoff & reduced effectiveness of the rain falling
  => less availability to farmer/ crop
<table>
<thead>
<tr>
<th>Met. Stations</th>
<th>Total Rainfall</th>
<th>No of days of rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesseneey</td>
<td>236</td>
<td>18</td>
</tr>
<tr>
<td>Shambuqo</td>
<td>357</td>
<td>30</td>
</tr>
<tr>
<td>Haikota</td>
<td>160</td>
<td>22</td>
</tr>
<tr>
<td>Alebu</td>
<td>76</td>
<td>11</td>
</tr>
<tr>
<td>Mogollo</td>
<td>450</td>
<td>19</td>
</tr>
<tr>
<td>Forto</td>
<td>246</td>
<td>17</td>
</tr>
<tr>
<td>Kulentebay</td>
<td>123</td>
<td>8</td>
</tr>
<tr>
<td>Aqurdet</td>
<td>533</td>
<td>26</td>
</tr>
<tr>
<td>Mensura</td>
<td>448</td>
<td>21</td>
</tr>
<tr>
<td>Duluk</td>
<td>182</td>
<td>9</td>
</tr>
<tr>
<td>Barentu</td>
<td>442</td>
<td>23</td>
</tr>
<tr>
<td>Goluj</td>
<td>603</td>
<td>25</td>
</tr>
</tbody>
</table>
Timing of Floods

- **Spate Systems with the smaller catchments**
  - most of the SOS FAIM schemes,
  - floods occur at the same time as the rainfall
  - No rainfall = generally no floods

- **Difficult for the farmer to**
  - both manage the water over the scheme and
  - to be able to fully utilise the flows.

- **Schemes with the larger catchments**
  - flood flows occur sometime after the rainfall
  - originate from Rainfall events in other parts of the wider catchment
  - 12 – 24 hour time lag
  - Useful as no rain often on scheme
What are we trying to do with these irrigation developments?

A. objective to improve livelihoods of the people living in the area.
B. Spate systems enables farmers to supplement the very variable rainfall with run-off => gives sufficient water to meet crop water requirements.
C. To ensure Sorghum and Millett crops receive sufficient water from surface run-off combined with rainfall to produce reasonable to good crop yields on a regular basis
D. Relies upon some rainfall occurring somewhere in the catchment => the smaller the catchment the greater chance of failure.
E. For larger catchment, even if there is no direct rainfall it is possible that there is run off in the Wadi that can be utilised.
F. Gash Barka has considerable periods with no rainfall which has resulted in crop failure or only stalks for the livestock.
G. Actual production from the smaller spate irrigation schemes as being only one year in three.
H. Have to try and ensure that when the production is achieved diverted water use is maximised => requires
   ✓ good on-farm water management,
   ✓ system that is ready to take advantage of the flood when it comes,
   ✓ farmers who can manage the flows that arrive in a satisfactory manner.
Overview of SOS Funded Spate Schemes

- 8 out of all spate schemes in Gash Barka
- Net cultivated area (2010) ~= 1,136 ha
- 10% of estimated Net cultivated area for all schemes
- Implemented from 2002 to 2005
<table>
<thead>
<tr>
<th>SubZdea</th>
<th>Year of Construction</th>
<th>State Scheme</th>
<th>Spate Scheme</th>
<th>Catchment</th>
<th>Area (km²)</th>
<th>Shape</th>
<th>Length (km)</th>
<th>Inigated Area (ha)</th>
<th>Scope for expansion (limitation)</th>
<th>Location of Scheme in catchment</th>
<th>Diversion Type</th>
<th>Water Distribution Method</th>
<th>Number of beneficiary households</th>
<th>Financier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Forto</td>
<td>2002</td>
<td>Welai</td>
<td></td>
<td></td>
<td>12</td>
<td></td>
<td>6</td>
<td>70</td>
<td>Nb (Land)</td>
<td>Bottom</td>
<td>Bunde/free</td>
<td>Spreading bunds</td>
<td>35</td>
<td>SOS FAiM</td>
</tr>
<tr>
<td>2  Forto</td>
<td>2004</td>
<td>Sanketkna</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td>4</td>
<td>120</td>
<td>Limited (water)</td>
<td>Middle/Upper</td>
<td>Masonry Wér</td>
<td>Spreading bunds</td>
<td>150</td>
<td>SOS FAiM</td>
</tr>
<tr>
<td>3  Hiland</td>
<td>2002</td>
<td>Bultubay</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td>4</td>
<td>152</td>
<td>Limited (water)</td>
<td>Middle</td>
<td>Masonry Wér</td>
<td>Spreading bunds</td>
<td>112</td>
<td>SOS FAiM</td>
</tr>
<tr>
<td>4  Hiland</td>
<td>2003</td>
<td>Alebu</td>
<td></td>
<td></td>
<td>19</td>
<td></td>
<td>8</td>
<td>138</td>
<td>Limited (water)</td>
<td>Middle (Steep catchment)</td>
<td>Masonry Wér</td>
<td>Spreading bunds</td>
<td>300</td>
<td>SOS FAiM</td>
</tr>
<tr>
<td>5  Mogollo</td>
<td>2003</td>
<td>Torkina</td>
<td></td>
<td></td>
<td>32</td>
<td></td>
<td>18</td>
<td>79</td>
<td>Yes (to 150)</td>
<td>Bottom</td>
<td>Masonry Wér</td>
<td>Spreading bunds</td>
<td>60</td>
<td>SOS FAiM</td>
</tr>
<tr>
<td>6  Agordat</td>
<td>2005</td>
<td>Reha Asey</td>
<td></td>
<td></td>
<td>35</td>
<td></td>
<td>3</td>
<td>100</td>
<td>Nb (Water)</td>
<td>Middle</td>
<td>Masonry Wér</td>
<td>Spreading bunds</td>
<td>50</td>
<td>SOS FAiM</td>
</tr>
<tr>
<td>7  Meusa</td>
<td>2004</td>
<td>Barabara</td>
<td></td>
<td></td>
<td>40</td>
<td></td>
<td>20</td>
<td>150</td>
<td>Yes (if Land)</td>
<td>Middle (Steep catchment)</td>
<td>Masonry Wér</td>
<td>Spreading bunds</td>
<td>75</td>
<td>SOS FAiM</td>
</tr>
<tr>
<td>8  Tesseny</td>
<td>2005-2007</td>
<td>Wed Keyar</td>
<td></td>
<td></td>
<td>45</td>
<td></td>
<td>4</td>
<td>124</td>
<td>Nb (Land)</td>
<td>Middle</td>
<td>Masonry Wér</td>
<td>Spreading bunds (partial)</td>
<td></td>
<td>SOS FAiM</td>
</tr>
<tr>
<td>9  Mogollo</td>
<td></td>
<td>Berhatara (IFAD)</td>
<td></td>
<td></td>
<td>45</td>
<td></td>
<td>26</td>
<td>60</td>
<td>Yes (to 1,200)</td>
<td>Middle/Lower</td>
<td>Masonry Wér</td>
<td>Blocks/Bunde</td>
<td></td>
<td>IFAD</td>
</tr>
</tbody>
</table>
Wakai Spate scheme - Forto
Sentketknab Spate scheme - Forto
Bultubaya Spate scheme - Forto
Alebu & Bultubaya Spate scheme - Haicota
Terkina Spate scheme - Mogollo
Terkina Spate scheme - Mogollo
Rahya Abay Spate scheme - Akurdat
Wedi Keyar Spate scheme - Tesseney
Berhatera Spate scheme - Mogollo
Berhatera Spate scheme - Mogollo
Summary Overview of Schemes

● Smaller catchment areas
  – more vulnerable to rainfall variations
  – have very short time between rainfall and run off
  – difficult to manage rainfall and run off together
  – Difficult for farmers to appreciate fully how they can utilise both at the same time

● The length and shape of the catchment is important
  – those close to hillside are more difficult to control
    ● stream is entering its floodplain,
    ● changing gradient rapidly
    ● high velocities
    ● more likely to be subject to frequent damage.
  – those in the middle to lower part of the catchment have a better conditions

● Diversion bunds/embankments without an orifice control cause a lot of problems => effectively diverting the river through the scheme.

● Embankment and bund control approach should not be excluded provided that Bund is used as a guide bound and that there is a restraint to prevent all floods entering into the system.
- Spreading Bund method of moving water across the irrigated area can be effective but
  - length should be limited
  - good levelling in areas which are undulating.
- The Senketknab scheme good example of reasonable working
  - built in a sensible location where land is even and contours are parallel
  - land does not require too much levelling.
- Where significant levelling is required with inexperienced operators this leads to patches
  of soil infertility => moisture stress in some parts of scheme.
- **Consider Sudan – GAS option**
- Division boxes needed at the beginning and end of the Main or Branch Canal => consider
  proportional dividers.
- Gates should be avoided wherever possible with flow being split in a proportional
  manner => gates should be on or off
- The masonry diversion weirs seem appropriate types of structure
  - durability of most has been shown to be good
  - within the skills of the local people.
- Gabions have a limited life when exposed to wadi/spate water flow
  - High content of the sediment in the water flow
  - sand can be very abrasive
  - larger stones hit gabions and snap the wire
  - if located in remote places => tendency for nomads and others to steal the wire.
- The type of scheme is being undertaken by IFAD more appropriate
  - water distribution method selected with block sizes => better & more even water
    distribution.
  - can be costly but it better to invest early rather than return repeatedly to repair the
    systems
  - Need to consider overflow approaches down slope
    - <2-3% slope; Length and width dependant on soil type;
    - Agree time for flows and duration => good WUA management
What is the current situation on the schemes visited

- Diversion works
  - Gates and stilling basin details need sorting out
  - Changes in river elevations at weir with construction
  - Sluicing arrangements
  - Approach flows – high & low
  - Consider sloping weir
  - Alignment of weir and river course
  - Operation of the gates – order, timing; responsibility
  - Alignment of Offtakes and sluice gates
  - Flow estimates to consider both weir and orifice flow together

- Relate flood flows, occurrence and volumes to intake capacity.
- All estimates are empirical and need verification using field measurements => great benefit to future designs
- No measure gauge exists on the Weirs and no one tasked with the responsibility for the recording and quantifying the flows
- Alternatives that could be considered on larger wadis
Flow through gates

Weir Flow

Orifice Flow
● **Conveyance network**
  - Need more use of proportional dividers + less gates.
  - Where gates are provided they need to be
    - user-friendly
    - have suitable mechanisms to enable them to be opened and closed quickly
    - Can be easily accessed for maintenance and repair
    - Preferably used in open or closed situation & preset levels
    - Avoid misuse by stronger/influential farmers

● **On farm water distribution and management**
  - Water spreading using contour bunds requires
    - relatively good land levelling => no ponding of water
    - enables slow sheet of water to move over whole agricultural area
    - land disc ploughed upsets this if not levelled again
    - no machinery are available to ensure finished level surface
    - within irrigated area, elevation variations of 15-30 cm occurs
    - Hinders even water distribution + rate of passage of water over the soil.
  - System of smaller basins where water is dropped from one to the other would reduce problems being faced by uneven land
  - Consider broad water front approach
- **Canal Design.**
  - needs to be revisited to account for
  - total flow through the sluice gate, intakes and over that weir
  - compare with predicted volume of flow in the floods
  - flood hydrograph has limited volume in the peak and although design should take as much flow as possible, the full force of the peak of the flood should be channelled down the river and not into the system.

- **Hydraulic structures.**
  - stilling areas of needs to be re-examined
  - not adequately designed downstream for the wide variation in flows
  - attention to control location of the hydraulic jump
  - needs depressed floor and sill
  - Needs bank protection immediately downstream of the structures to avoid the “onion” effect.

- **land levelling.**
  - limited availability of animals suitable for land levelling
  - initial construction levelling using dozers and graders
  - alternative open to farmers is machine levelling or improved disc ploughing + second harrowing (power)
What is status of Water Uses Associations

- Generally formed and trying to complete tasks
- Are we trying to us to do too much considering the age distribution and resources available to them?
- Farmers are Agro pastoralists used to periods with less crop production => livestock in those years.
- Grain is grown for both human consumption and for the livestock
- Operation and maintenance charges
  - Level of charges related to crop in good year
  - Nakfa 500 (~US$ 30) reasonable in these circumstances
  - What communities can do and what government can do
- Investment considerations and types of structure
Assistance to WUAs

- Training should consider items mentioned above
- Activities to be worked out with WUA considering the level of money collected in good year
- Fee may only be collected in 1 year in 3
- Fee based on average yields (10 to 15 quintal per hectare) in good year
- Assume that system has
  - been built to a good durable standard
  - system completed
  - any flaws in the construction or the design will be repaired by government rather than the farmers.
Constraints to be faced when making improvements

- number of issues to be taken into account
- experience of the last few years can be well utilised
- should not avoid difficult issues
- measures should be put in place to reduce the impact

A. Designs and Experience

a) Lack of institutionalisation of experiences. Many variations in types of systems used but no documented evidence on performance and how to improve upon the built designs to reduce annual recurrent expenditure and maintenance.

b) Relatively high staff turnover with insufficient knowledge hand over at intermediate to senior level.

c) No single approach to spate design however the designs are often lacking the benefit of practical experience when adapting hydraulic structures to the field.

d) Limited peer review of the designs and insufficient design manuals to guide the less experienced designers.

e) Designs need to be more tailored to the operational capacity and ability of farmers/WUAs

f) Need to invest more in construction to reduce recurrent expenditure.
B. Construction

a) Timeliness and availability of suitable construction machinery, materials and labour due to other demands.

b) Limited availability of skilled masons and experienced machinery operators (a) machinery comes from a central pool (b) wide variety of work with few having experience of the requirements of good land movement in levelling.

c) Lack of appropriate equipment for improved land preparation
d) Failure to undertake full land preparation/formation at construction.

C. Water Users Associations and Farmers Involvement

a) Tasks required of farmers not explained to them adequately during construction

b) Many of the tasks assumed to be undertaken by farmers are beyond their ability particularly considering the numbers in each WUA.

c) No clear direction on how much farmers will be able to contribute towards O & M charges and how this should be spent.

d) Insufficient funds for routine repair of items such as breaching of bunds and repair of canals and intakes of example.

e) Farmers in some cases have tried to repair the works but mostly ineffective and repairs failed in the following flood season.
D. Impact of Constraints

- Failure to complete all of the required works in time for the first flood season and to be able to hand over to the farmers a system that is sustainable and within their means to maintain
- Continual high annual expenditure on maintenance and repairs
- Water distribution is still poor in many cases with crop yields varying considerably over the command area.
- Lack of sufficient quality on some aspects of the work during construction, particularly relating to the on-farm works.
Are systems provided sustainable, if not why not?

- require high annual recurrent expenditure beyond means of farmers.
- if the technical problems and repairs are not undertaken reasonably promptly and in a sustainable way, the systems will deteriorate and be unable to continue to deliver water as anticipated.
- it has to be recognised that the systems will only deliver grain probably in one in three years but in that one year with good water management and water distribution it is possible for the farmers to obtain sufficient yields to take them through the two dry years.
- can also be anticipated that in one of these two dry years, farmers will be able to achieve some fodder for their animals even though rainfall may be small and there could be one or two floods within the Wadi.
- Can spate irrigation be analysed in the same cost benefit way as for other schemes?
  - When analysing the impact of the state irrigation systems that are properly designed and implemented, it must still be realised that they are highly dependent on the vagaries of the rainfall.
  - The situation when there is no rain must be taken into account in the analysis as when the farmers are not able to grow their own crops, they are dependent on government and others for support.
  - In addition to this, the farmers also have livestock which can both be an advantage to them in dry years but also contains their wealth and can be lost if drought persists.
What is now required to improve chances of sustainability

A. Are we going to invest in more schemes and on what basis?

B. What is to be done about existing schemes that still require significant investments?

C. How can we consolidate what has been done and make systems durable and sustainable?
Proposals:

- Now consolidate the existing schemes using the experience of the 35 schemes in Gash Barka.
- Plan in parallel to develop more schemes but ensuring that they utilise the experiences so far and that a more systematic approach to design and implementation is adopted.
  - Consolidation of experience to produce good designs that will require minimum expenditure in the future from the farmers
  - Working order uses associations that can take over what is required and what they can do
  - A full estimate of outstanding design problems and maintenance needs
  - Improvement of on-farm works to ensure that water distribution is improved and that breaching of the bands is repaired and secured against future problems
  - Standard designs that will overcome the past efficiencies in the design they have produced relatively high operation and maintenance costs
  - Designs that are tailored to farmer management and also endeavour to reduce Operation and maintenance needs through greater capital investments.
What does this mean to MoA and SOS Faim - Way forward?

- Adjustment of programme for 2010 and 2011
- Detailed assessment of each scheme, design for overcoming constraints and costing of improvements
- Repairs prepared considering improved designs in locations and details where problems have been identified.
- Assessment of the performance of the 35 spate irrigation systems in Gash Barka to identify good practice and why this has taken place in relation to physical conditions, size of catchment, participation of farmers, quality of design, quality of construction, appropriateness of the design for farmer operation and other pertinent issues.
- Development of guidelines for the field staff recognising the practical experiences that have been gained over a number of years.
- Ensure that good documentation is kept on all schemes and designs together with drawings so that these are available within the institution Should the staff be transferred or leave.
- Ensure peer review of the designs and that methodologies are developed for facilitating cross checking and review.
- Data on each flood flow at each spate site should be collected so the comparison can be made with empirical data and predictions. If possible, rain gauges should be established at each village and the water user Association trained and take responsibility for recording actual rainfall.