

**Water in the Sand:  
An Evaluation of SASOL's  
Kitui Sand Dams Project**



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A socio-economic assessment of SASOL Foundations Kitui Sand Dams project prepared for:

SASOL Foundation  
Mennonite Central Committee  
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**1.0 Executive Summary**

1. *The purpose of the assessment mission*

The mission purpose was to document and evaluate the outcomes and impacts that flow from SASOL's construction of some 370 dams in Kitui district, Kenya.

2. *The approach of the assessment Team*

The four-person Team was on-site in Kitui district for five weeks from the end of June to the beginning of August 2005. A stratified sampling technique was used to select 30 dams from a population of 367 dams. The Team spent a day at each of the 30 dam sites. We inspected the sand dam, met with community members and community leaders, and 6 or more persons were interviewed on their *shamba* in each sand dam community.

3. *Kitui district*

Kitui district is one of 12 districts in Eastern Province. The population density is 27 per square kilometre. Rainfall varies from 250 to 750 mm annually, falling in brief, heavy showers in two seasons. Rains fail frequently so agriculture is high-risk, especially for the staple foods, maize and beans. In the dry season it is not uncommon for women to spend several hours to collect minimal amounts of water to meet the family's basic requirements.

4. *Project outputs*

The primary project output is the construction of a stone and cement barrier in a stream bed to collect and hold sand that washes along the stream during the rains. The water is stored in this sand and can be accessed with a traditional scoop hole or with the construction of a well. Complementary project outputs are organization of a sand dam community to construct and maintain a dam and capacity building to limit soil erosion, undertake terracing, plant grass and trees and to construct latrines. These activities allow a sand dam to mature, limit contamination of the sand and water and encourage additional water harvesting activities. Where SASOL Foundation provides selected expertise, strategic inputs and training, the intent is that a community organize to identify its development constraints and to take action to overcome key constraints such as the lack of accessible water.

5. *Accessible water is the primary output of a sand dam*

The development potential of increased supplies of relatively accessible water from sand dams has been demonstrated in a number of the sand dams that have been constructed with assistance from SASOL. In a time of drought, as occurred during this socio-economic study, this development potential was being realized with water available in at least 50% of the sand dams.

6. *Community participation*

As limited supplies of water are a major constraint in the area, community investment in a sand dam is essential for the wealth of that community. The time saved in collecting water represents a level of payoff that justifies this large investment by a community.

7. *SASOL's point of contact with a community*

In most cases SASOL's point of entry to a village was via the Chief and sub-Chief to the village elder. This approach has led to a perception in some villages that constructing a sand dam is SASOL's idea, not their own preferred solution to the primary problems faced in the village. A related issue is SASOL's role in locating the site of a dam. If the location is not where they traditionally sought water in that stream or it is located inconveniently from where the people live, the interest in and sense of ownership of the sand dam constructed tends to be relatively low.

8. *The timing of dam construction*

The timing of dam construction affects the ability of the members of a community to participate in dam and well construction. Working out a construction schedule between SASOL and members of the community that recognizes competing labour needs during land preparation and planting and during harvest will increase the possibility of timely participation by all members of the sand dam community.

9. *Community leaders as an important variable in sand dam success*

Good community leadership increased the likelihood of successful maturation of a sand dam. Good leadership included:

- mobilized all members of the sand dam community and kept them involved;
- insured that information was passed on to members of the group; and
- guided the group to select committee members who had relevant interest and abilities, included significant female representation, and assured that all areas of the community were represented.

10. *The continued role of a sand dam committee*

An active committee that continues to guide and serve a sand dam community after the completion of the concrete and stone sub-surface barrier is essential for community activities required to allow a sand dam to mature and to keep it relatively free of contamination so that it provides a source of water to address the human, livestock and agricultural requirements of the sand dam community.

11. *The value of a strong community spirit*

Community spirit, with a tradition of undertaking group activities, proved to be an important determinant of the provision of encouragement and assistance required for such sand dam building activities as trenching and terracing of farm land, digging of pit latrines, and the planting and growing of grass and trees. Community spirit also affected the distribution of benefits from a sand dam through the provision of plots for vegetable growing, resolving issues of potential conflict, as well as assisting each other in various other ways.

12. *The place of protected banks of a sand dam*

An important factor in the failure to achieve the essential complementary activity for a mature sand dam is a lack of definition of what constitutes the "banks" of the sand dam. This has led to misunderstanding and conflict between the owners of land adjacent to the dam and the other villagers who constructed the sand dam. An oral understanding, in which the owners of land adjacent to a sand dam grant permission to a sand dam community to construct a dam and assure members of the group access to its water and sand, are proving inadequate to define responsibility to prevent the continued silting of the sand dam and to resolve conflicts between such land owners and the sand dam construction group.

13. *Capacity building to create an understanding of what is a sand dam*

In some cases, the sand dam community involved did not understand what constitutes a sand dam. They were under the impression they were constructing a traditional dam designed to hold surface water. As a result, they were unaware that the realization of dam benefits was dependent on a dam maturing to a sand dam. The capacity building

extended by SASOL prior to and during dam construction was inadequate to emphasize the need for community action to prevent silting, to maintain the dam, and to repair both the dam structure and the means of preventing the silting of the dam.

*14. Increased agricultural production*

Realization of project agricultural production outcomes is dependent on two elements: availability of water from the sand dam and freeing of significant time from the task of fetching water. Time saved tends to be expended primarily on agricultural activities, including terracing of farm land. Increased production is evident where terracing is combined with the planting of grass to protect the terraces and composting to fertilize and increase the organic content of the soil.

*15. Links between managing sand dams and agricultural production*

New crops are being produced – primarily vegetables and fruit trees – by land owners adjacent to the sand dam, by farmers or groups who have been granted access to or leased land near the dam site, and in some home gardens. Also, farm productivity is increasing as women invest the time saved in collecting water in soil preparation and in harvesting of crops. Finally, land in the bottom of the valley is becoming more productive as the water table rises.

*16. Improved livestock production*

Prior to sand dams, in periods of severe drought some animals died. Now, with the planting of grass to protect terraces and the banks of sand dams, the supply of fodder has increased. Also, animals do not have to walk as far to be watered and can be watered daily rather than every other day. Hence animals are less likely to die during drought. The effects of this saved energy and increased fodder supply are increased milk production and better quality animals – primarily goats – sold for meat.

*17. Planting trees for fodder*

Lack of pasture currently limits livestock production. Capacity building that encourages the planting of trees and shrubs suitable for fodder can augment the current supply of grass and fodder available.

*18. Water availability and increased business opportunities*

Increased availability of water is generating some agriculture-related business opportunities. Young men are producing vegetables for sale locally and in surrounding markets. Road side kiosks are emerging as places where fruit and vegetables can be bought and sold locally. Some women have taken up the purchase of fruits and vegetables in area markets and then re-selling these food items locally. Brick-making for sale was also made possible by increased water supply in some villages.

*19. Food security is defined by access to maize and beans*

At the household level food security is defined primarily as access to two staple foods: maize and beans. During time of drought, when maize and beans cannot be grown readily, food coping strategies focus primarily on own farm production – other crops and selected livestock – as the source of income to buy maize and beans. Therefore, achieving food security involves a strategic use of scarce water resources to produce specialty crops, sustain livestock or produce goods (e.g., brick-making), that command maximum quantities of maize and beans in market sales and exchanges.

*20. Role of soil and water conservation in achieving food security*

During this period of drought, the households that had put into practice sound soil and water conservation practices were best able to buy maize and beans. The practice of such techniques was more evident some distance from streams and sand dams than on land nearer to water, reflecting the higher opportunity cost of fetching water and hence a greater appreciation of alternative water harvesting techniques. The importance

these households attached to farm production as the means to food security is evident in their investing scarce resources in their farms rather than businesses.

*21. The adoption of improved farming practices*

The adoption of new water use technologies is not carrying over as yet to widespread adoption of improved farming techniques and practices. There was limited use of ridging and planting in rows, limited pursuit of new approaches to developing fodder for animals, limited use of improved varieties of seeds or evidence of knowledge of the preferred means and time for planting.

*22. Gender issues*

Given a need to mobilize the community a man was seen as more appropriate for the position of chair of the site committee. Similarly, given the need for trust in the collecting, holding and spending money, a woman was preferred for the position of treasurer. The inclusion of both men and women on the committee created a democratic platform for decision-making and the active participation of women. Where women as well men had a voice in this democratic process opportunity was provided for all to participate in the construction of the sand dam, which, in turn, increased the community's sense of ownership of this major investment.

*23. Impact of increased access to water on the well-being of women*

Women carry primary responsibility for water collection. The provision of cleaner, more accessible water improves the overall health of the women. Less energy is expended collecting water providing more time for the family, more time for agricultural activities, more timely preparation of meals, more time for group activities, and some time to relax.

*24. Impact of increased access to water on the well-being of children*

Water availability in a sand dam reduces the time children spend collecting water. This increases security in that girls no longer have to travel far to collect water and they do not have to collect water early in the morning or late in the evening. As a result they eat more meals, eat on a timely basis, they are able to spend more time with their family, and they have more time to attend school, which provides for a better education. Increased food production, especially fruit and vegetables, enables them to consume a greater variety of foods and improves their overall health and nutrition.

*25. Addressing water-related diseases*

Diseases related to water and sanitation can be prevented. An increase in the supply of water, when combined with the practice of safe hygiene - construction and use of pit latrines, small jerrican with water next to the latrine for hand washing, more regular bathing, washing of household utensils, use of drying racks for dishes, and reduced contamination of the sand dam by humans and animals - can reduce significantly this set of diseases.

*26. Animals as a primary source of sand dam contamination*

Visible evidence of contamination of the sand was observed in 60% of the sand dams. The important place of animals within the livelihoods of people and the close proximity of such animals to the living space of people implies the role of animals in contaminating sand and water in a sand dam is not understood adequately at the household and community levels. Preventing animals from entering a sand dam is a primary means to a cleaner source of water for household use.

*27. Potential for greater crop diversification*

The addition of water from a well-managed dam opens the potential for diversification in crop production. In the limited number of cases where it was observed, the households were better able to provide for food security. When the rain fails, maize and bean crops

fail. With a more diverse cropping pattern the risk of a total crop failure is reduced as crops like sorghum, millet, pigeon peas, cassava, etc., will survive.

28. *Increased biodiversity*

Availability of water enables seedling production and the planting of seedlings earlier to enable tree growth to take full advantage of the rains. The increased growth of exotic trees for fruit, firewood, and commercial use of wood plus the planting of napier grass represent new and wider range of species in the area. Together they should increase soil fertility, offset deforestation, increase the local supply of fruit, and make fruit available locally at a lower cost.

29. *Migration effects of new economic opportunities*

Where agriculture-related business opportunities were being pursued there was evidence of a reduced need for out-migration, especially by young men, to seek employment. At this early stage it was not possible to assess the impact of these changes in migration patterns on the social and economic stability of the community.

30. *An understanding of resources inter-relatedness*

Individual farmers engaged in specific soil and water conservation actions. But, there is only limited evidence that they understand how the various factors – soil, water, vegetation, animals and humans – are inter-related. Capacity building is still needed to develop an understanding of farming systems that conserve and utilize scarce resources on a sustainable basis.

31. *Recognizing the economic value of water as a scarce resource*

Current farming practices do not reflect the economic value of water within a farming system. There is no sense of channelling water to agricultural activities with the highest rate of return per litre of water utilized. Nor is there ready adoption of water conservation methods, e.g., drip irrigation and mulching. As a result, community action does not recognize a need to conserve scarce water supplies, especially in time of drought, to assure water will be available for human consumption and other essential uses of water.

32. *The effectiveness of SASOL's training*

Where training had been provided by SASOL, there was some evidence that the members of the community did not understand adequately the training received. Some examples of failure to act on the training message provided were in the areas of animals contaminating the sand dams, soil conservation, terracing, and the planting of trees and grass.

33. *Restricting access as a means to motivating participation*

Site committees tended to use restricting access to the outputs of a sand dam or a well as a means to motivate participation. This did not achieve the desired effect in a number of sand dam communities. Indeed, in some cases this has become a source of conflict within a community. Given accumulated experience SASOL may want to advise site committees of the implications of restricting access to motivate participation. For example, the contribution of households who participated initially, but withdrew for practical reasons such as a need to find food or to plant crops with the onset of the rains, needs to be recognized. A failure to do so will make it more difficult to promote cooperative activities in the future.

34. *Promoting collaboration among development agencies*

In some communities up to five government ministries and NGOs were active in related activities. The competition among these agencies limited focus on a comprehensive development strategy that was able to build on the potential presented by a sand dam. Given that SASOL lacks capacity to address all aspects of agriculture and rural

development related to water, promotion of collaboration among agencies should be considered as a way forward.

*35. The need for project monitoring and evaluation*

An effective system of monitoring and evaluating the maturing of sand dams was not in place. A failure to monitor and evaluate community follow-up activities after the construction of a dam reduced the realization of the overall development impact of dam construction.

*36. Maintaining a supply of water for human consumption*

The use of chemical pesticides and fertilizer for vegetable production in stream beds or in the proximity of a sand dam may have long-term harmful effects. This needs to be monitored and appropriate knowledge on pesticide use will need to be extended to farmers. The current practice of growing vegetables during the dry season serves to reduce the need for pest control. Promoting crop rotation within these vegetable gardens also will serve to minimize problems of pest infestation.

*37. Monitoring adverse effects chemicals on water and food*

The potential harmful effect of chemical residues on fruit and vegetables also needs to be monitored. Farmers and consumers may not understand the recommended waiting period after spraying of chemicals before such fruits and vegetables are consumed as well as the need to wash. Similarly, the potential adverse health effects of long-term use of chlorine to purify drinking water are unknown and need to be monitored. Attempts to clean a well by pouring in chlorine can be dangerous.

*38. Addressing the problem of high salt content in the water*

Given an unpalatable salt content in the water in 10% of the sand dams suggests a potential payoff from some research on the actual chemical content of the water, methods of water collection that minimize the concentration of undesirable chemicals, methods of water use that might offset some of the adverse effects of this chemical content, and preferred ways to use such water productively. Documenting the experience gained at dams with salt water may also transfer useful information among sand dam communities so affected.

## **2.0 The Recommendations of the Assessment Team**

*1. Constructing sand dams as the priority output*

The development outcomes and impacts of sand dams warrant SASOL's continued investment of resources in the promotion and construction of sand dams.

*2. Guiding sand dam communities to achieve mature sand dams*

To achieve the development potential of sand dams it is recommended that SASOL's investment of resources goes beyond the construction of a dam – a concrete and stone sub-surface barrier – to include the active promotion of community activities required to enable the constructed dam to mature into an operational sand dam.

*3. Action to promote community involvement*

Involvement of members of the sand dam community in decisions related to the development of a sand dam is important to build a sense of commitment and ownership of the construction project. Employing participatory methods, SASOL should continue to build knowledge and understanding within community members of what constitutes a sand dam and to obtain their commitment to undertake, jointly with SASOL, this major investment in a community asset. The content of such an understanding include:

- direct involvement of the sand dam community in decisions on whether to construct a dam and where to locate the dam;

- a detailed cost estimate of the proposed sand dam, including a monetary estimate of the community's inputs as well as the inputs supplied by SASOL;
- scheduling of dam construction in consultation with community members to assure their availability for the intensive, concentrated effort involved; and
- selection of a site committee with requisite skills and representative of the people in the sand dam community.

4. *Promoting community spirit for collective action*

To achieve sand dam success it is important to promote community spirit to facilitate group or collective action within the community. Factors to consider in promoting community spirit include:

- Assure that both men and women are involved:
  - build on women's traditional responsibility for collecting water and their awareness of the health and time saving benefits that are likely to flow from sand dam construction; and
  - men are needed to undertake heavy work associated with stone breaking, well digging and terracing, etc. There is a need to expand their awareness of how investment of time and efforts in such activities will address the adverse, constraining effect of water availability on all aspects of their farming activities.
- Assure all areas and various active groups are represented on sand dam committees.
- Assure that the young people of the village are also drawn in to increase their awareness of the value of the dam and the opportunities presented by a larger supply of water.
- Give explicit attention to resolving conflicts or the existence of factions within the community.
- Where possible build on cooperation already evident in group activities in the community.
- Build in accountability for members of the community, including the support of elders, sub-Chiefs and Chiefs.

5. *Defining and marking the outer limits of the banks of a sand dam*

As part of the preparation for the construction of a dam it is recommended that SASOL and the dam site community jointly define and mark the exterior boundaries of the sand dam banks as required to enable the constructed dam to mature into a sand dam. This may take the form of the Ministry of Water defining and marking the sand dam or it can be an agreement negotiated between the owners of the land adjacent to the proposed dam and the legal representatives (person(s) with signing authority) of the sand dam community.

6. *Written, signed agreement between landowners and the site committee*

It is recommended that the agreement between the adjacent land owners and the dam site committee be in writing, signed by the owners of the land and the legal representatives of the committee. In addition to the standard provisions of permission to construct a dam and assured access of community members to the sand dam, the agreement should formally state the exterior boundaries of the sand dam banks as defined and marked in recommendation 5) above. This definition of boundaries should locate all responsibility for use and development within the boundaries to the sand dam community and define expected actions by the land owners for adjacent land beyond these boundaries as required to enable the constructed dam to mature into a sand dam.

7. *Timing of dam construction*

Each SASOL mason is expected to construct three sand dams annually. This affects scheduling of dam construction and limits options for site committees to establish construction schedules appropriate to the community. Such a schedule needs to identify the season when the members of this community have time and the resources to undertake the construction. Assembling the construction material in advance of

construction will reduce the time and community effort required to construct the dam within a two-month time frame as recommended by SASOL.

8. *Sustaining activity required for sand dam construction*

Constructing a dam is only a first step in sand dam construction. Focused effort to mobilize and supervise community action, similar to that required to build a dam, is needed to sustain the initial construction activity so a dam can mature into a functional sand dam with water for use by the sand dam community. As is the case for dam construction, a committee representative of the sand dam community is required to assure this complementary activity is undertaken on a timely basis and in an appropriate manner. The role and responsibilities of the committee need to be defined clearly to assure that focus is directed to promoting technologies for sand dam maturation and shallow well construction.

9. *Plant growth to maintain the banks of the sand dam*

The current SASOL practice of promoting napier grass as a combination of protective plant cover and livestock fodder is sound, provided the napier grass is maintained. Where the community and adjacent landowners are unable or unwilling to assure adequate plant cover is maintained it is recommended that bushes or shrubs be planted that are not eaten by animals and have no commercial value.

10. *Linking dam construction with an enclosed well with pump*

As a Team we affirm SASOL's current policy of linking dam construction with the digging of an enclosed shallow well complete with a pump. Current practice, though, appears to leave unresolved who is to take the initiative to start the process of well construction after a dam has been completed. This lack of resolution needs to be clarified to overcome the current inaction in a number of sand dam communities that have constructed a dam in 2002 or later.

11. *Establishing a system of project monitoring and evaluation*

To guide SASOL's involvement with the sand dam community after the completion of a dam it is recommended that SASOL put in place a system for monitoring and evaluation of project activities. This system would range from gathering relevant baseline information prior to dam construction to the documentation of project outcomes as defined in the project's Logical Framework Analysis [LFA] (logframe).

12. *The content of a monitoring and evaluation system*

A monitoring and evaluation system should promote participation by all stakeholders in all components of a project management cycle. The intent is to obtain joint reflection on project progress, identification of implementation gaps, a sharing of experience gained, and a process of joint planning that builds on experience gained to fill the gaps identified and to move the project forward to its intended purpose and goal.

13. *Capacity building*

For SASOL staff there also is a need to recognize that their message of what constitutes a sand dam generates outcomes only when the sand dam community acts on that message and advances the maturing of a sand dam. To build this capacity there needs to be a comprehensive training module on activities required for a dam to mature plus a monitoring and evaluation component that provides information on the application at the community level of that training module. Such a package will ensure continuous follow-up on the use of knowledge and skills, identification of gaps in the training process, and feedback that informs changes in the training module and training approach.

14. *Advancing the effectiveness of training and capacity building*

A sand dam community needs to understand what it is to which they are committing themselves. Building this commitment calls for effective training within the community. To be effective capacity building needs to consider such factors as: how fast can members of the community absorb information? How much information are they able to absorb at one time? Are training messages being offered by several groups in the same time period? If so, are the messages presented complementary or competing for community attention and action? In response to factors such as these training programs need to be offered at a time, level and pace that can build the required knowledge and capacity required for project implementation. Training that follows up on dam construction is more likely to foster action required for sand dam maturation as it occurs when the members of the community observe what is and what isn't happening.

*15. Building effectively on the development potential of increased water availability*

SASOL is encouraged to be open to promoting and participating in collaboration and networking with Ministries and NGO's active in the project area. Specifically, SASOL should: 1) confirm what others are doing so that they can link up with other agencies that can complement SASOL's capacity building; 2) re-enforce the message where there is overlap in training curricula themes; and 3) fill in the gaps in the training being offered by the other agencies active in the project area.

*16. Training to advance the inter-relatedness of resources and humans*

To advance agricultural production the training curriculum needs to include material on how water, soil, vegetation and human activities are related. Expanding understanding among community members in this area will facilitate the process of the sand dam maturing, increase agricultural production, and contribute to obtaining and maintaining better water quality for the community.

*17. Promoting improved agriculture practices*

The effectiveness of training to promote agricultural production and achieving greater food security will be enhanced by emphasizing the importance of planting crops in rows along ridges, the potential of crop diversification, and the importance of crop rotation.

*18. Minimizing the contamination of water at the sand dam*

Action is required to protect better the source of water for human consumption. Merely enclosing a well and adding a pump does not assure contamination of ground water will not occur. The area around scoop holes and shallow wells needs to be kept free of contamination by both humans and animals.

*19. Food, nutrition and the health status of the community*

Mature sand dams have increased the supply of water at the household level for growing vegetables, cooking, drinking and washing. Capacity building to promote appropriate hygiene and sanitation practices should be emphasized to ensure this available water is not contaminated. To facilitate evaluation and monitoring of training content and training effectiveness health and nutrition indicators should be included in the baseline data collected.

*20. Increasing awareness of the nutritional value of available foods*

Food and nutrition training should incorporate a deliberate campaign to increase awareness of the nutritional value of indigenous foods and the new crops grown. The intent will be to ensure high-nutrition foods are not merely sold, but consumed as well. These foods can supplement the staple foods, maize and beans, improving the household basket of food intake and improve the nutritional and health status of the household members.

*21. Place of livestock fodder within promoting increased biodiversity*

Training designed to promote increased biodiversity should focus on trees and shrubs, e.g., lucerna species, which will provide fodder for livestock. As livestock form an important part in food coping strategies during drought, an increased supply of fodder will have food security impacts as well.

*22. Conservation and water use practices*

Given that water is the constraining factor for farm households in Kitui District, training that fosters conservation in the use of water will serve to reduce this constraint. Some examples include drip irrigation and the practice of mulching.

*23. Watering the animals*

Experimentation with alternative animal watering systems is encouraged. Some examples may be a pump that lifts water into a communal trough outside of the sand dam or a pump that raises water to a holding tank from which animals can access water through individual drinking cups activated with pressure from the nose of the animal. The intent should be a watering system that is technically feasible to operate and maintain, is within the economic means of a community, and minimizes the spread of disease among animals.

*24. Follow-up action for existing dams*

There is a need for SASOL to meet with the sand dam communities involved and to assess jointly with the members of these communities what has and hasn't happened and the effect of such action/in-action on the maturing of a sand dam. These consultations can provide opportunity for the transmission of knowledge and technical advice to enable a community to realize a mature sand dam; in some cases selected community members might be drawn into relevant training sessions being offered in the area; and SASOL can draw on this experience to inform future training and development initiatives.

*25. Establishing a basic water testing facility*

Establishing such a laboratory, where water samples can be tested for a modest fee, should be encouraged either in the Ministry of Health, the Ministry of Water, or in the private sector. The existence of a basic, accessible laboratory would facilitate SASOL's monitoring and evaluation of project implementation and, ultimately, would enable sand dam communities to obtain and maintain water quality suitable for the needs of their respective communities.

*26. Research on the salt content of sand dam water*

Deep disappointment sets in within a sand dam community when the salt content of the water is so high that it is unsuitable for human consumption. To address this disappointment some research should be undertaken to analyze the chemical content of the water and to advance options for offsetting the effects of or reducing the salt content of the water. At a minimum, SASOL should document experience gained at sand dams with salt water and disseminate this information among sand dam communities so affected.

### **3.0 The Project Assessment Mission**

#### **3.1 The Purpose of the Project Assessment**

SASOL Foundation is active in securing ecologically friendly water sources in communities affected by severe water shortages. With a number of years of experience they have perfected a sustainable system using technology that has become known as the *sand dam paradigm*. This paradigm is built on water as an entry point to development.

SASOL has constructed in excess of 370 sand dams in Kitui District. Essential elements of the sand dam paradigm as applied to these dams include:

- introduction to a community of external technology and adapting it to specific local physical conditions and social circumstances;
- at a sub-location level, involving 25 - 50 trainees, use of participatory methods to define need for a sand dam and to obtain a willingness to invest community resources in the construction of a dam;
- formation of a site committee, via community elections, to implement construction of a sand dam, including the assembly of local resources, organizing the provision of community labour, and providing room and board for an artisan who supervises construction;
- external assistance for an artisan with the masonry skills to construct a sand dam, selected inputs such as cement, reinforcement bars and some tools and equipment that need to be purchased and brought into the community, and technical advice;
- formation of a site committee to maintain the sand dam, to manage drainage into and drawing of water from the sand dam area, and to encourage complementary water harvesting, agricultural and environmental activities; and
- external provision of natural resource management training for the sand dam management committee and other members of the community.

SASOL's place within this process of sand dam construction is that of a catalyst and facilitator. Community members define the problem, set priorities and make decisions that lead to solutions. SASOL has covered the cost of seeking out appropriate water harvesting technology and the activities and investments required to minimize the cost of implementing the new technology and maximizing the productivity generated by the technology. This includes combining expertise and knowledge from the Technical University of Delft (Netherlands) and universities in Kenya with the needs of local communities in Kitui District. It also includes the training of artisans to construct sand dams by drawing on the labour of the local people and other resources available within a community. This linking of external technology with community organization and effort promotes efficient use of local capabilities and resources for economic development that reduces the technology gap among communities and increases the income and well-being of community members.

The purpose of this assessment mission was to document outcomes and impacts that have and continue to flow from this process of constructing 370 dams. Realization of this purpose required systematic collection of data that provide measures for each outcome and impact in a set of outcomes and impacts seen as potentially relevant for a water-centered food security and development project.

The work of the Assessment Team was guided by Terms of Reference formulated for the mission. The Terms of Reference are attached as Annex D.1 to this report.

## **3.2 The Assessment Methodology**

### *3.2.1 Team members*

The range of water, agriculture, food, health, environment and socio-economic indicators associated with the set of outcomes and impacts identified made necessary a team approach to data collection and analysis. The Team members were:

- 1) Henry Rempel - an economic development specialist to assess the changes in output levels, income, health and nutrition, food security, and development potential of the communities and households directly associated with sand dam construction and utilization.
- 2) Charity Wanjiru Nyaga - a nutrition and community development specialist to document: nutritional outcomes and impacts of sand dams; jointly with Peter Gaff, community organization and co-operative activities; the dynamics that govern

mobilizing involvement, establishing and retaining rights of access and use; community approaches to assuring responsibility to maintain, protect and sustain community investments; community methods for resolving conflicts that occur; and the impact of co-operative approaches to water harvesting on household income, food security and overall well-being. With input from other Team members, especially Hilda Kalekye Manzi – she also documented the gender aspects of the sand dam paradigm and assessed the gender-related outcomes and impacts associated with the application of this paradigm.

- 3) Hilda Kalekye Manzi – an agriculture specialist to document changes in agricultural practices and output, assess the impact of agricultural changes on the income, food security and overall well-being of the community members. And, jointly with Peter Gaff, assess the environmental impacts of community efforts to develop water harvesting methods as well as complementary actions for water harvesting, water use, and agricultural development more generally.
- 4) Peter Gaff - worked jointly with the other three Team members with a specific focus on the organization and political dynamics of the sand dam paradigm and on the environmental outcomes and impacts of project inputs and outputs

### 3.2.2 Selection of random sample of sand dams

The sampling procedure was a form of stratified random sampling. To assure a sample that reached across a range of stream catchments SASOL field staff generated a list of streams to be included in the assessment’s field visits (see Table 1). From a list of dams on each of these 18 streams the number of sites on each stream, as listed above, were selected at random. The set of 30 dams selected are listed in section 3 of Annex D. This sample is deemed to be representative of the 370 sand dams in the project population.<sup>1</sup>

**Table 1: Catchments Selected for Random Sampling of Dam Sites**

Stream	Number of Sites	Stream	Number of Sites
Kisiio	3	Mbusyani	2
Kyeemukaa	2	Ethi	2
Mwiwe	2	Ithambaka	2
Kyuusi	2	Mavia Matune	2
Kwa Mbai	1	Kithiano	2
Ikindu	2	Muthungwe	1
Kiindu	2	Kalikuvu	1
Nduni	1	Yatta	2
Wii	2	Ngwani	2

### 3.2.3 On-site inspection and interviews

The primary data collected was from on-site inspections, meeting with community leaders and interviews with selected household members who were resident there. To obtain differing perspectives within each sand dam community households were selected from near the dam site, an intermediate distance from the dam site, and the outer range of that community.

For each sand dam community selected for the field assessment an obvious reference point was the completion of its sand dam. The intent was to collect a set of current observations

<sup>1</sup> For example, the sample breakdown by donor was: DFID – 66%, SIDA – 27% and MCC – 7%. The population breakdown is: DFID – 57%, SIDA – 34% and MCC – 9%. Where the sample slightly under-represents SIDA and over-represents DFID, these overall ratios are one indicator of a “representative” sample.

and then to ask the respondents to compare this with what was the situation prior to the existence of the sand dam. Some sand dam sites were more mature than others, so a comparison of data from a number of dam sites enabled the Team to document evolutionary changes that were occurring subsequent to the completion of a sand dam.

In addition to this field survey data was drawn from several other sources (see section 4 in Annex D for a list):

- Interviews with project officers involved in funding the Kitui Sand Dams project - SIDA , DFID, and World Neighbors - or involved in constructing dams - Catholic Diocese of Kenya;
- separate assessment of capacity and performance of SASOL as a program/project implementing agency;
- interviews with officials with the Ministry of Agriculture and the Ministry of Water; and
- one local health clinic that serves the immediate health needs of the communities associated with several sand dams that were assessed.

#### **4.0 Water, Food Security and Development in Kitui District**

Kitui district is one of 12 districts in Eastern Province. The land area is 20,402 km<sup>2</sup> and the population exceeds 500,000. A population density of 27 persons per square kilometre is approximately half that for Kenya, indicating the relatively marginal farming potential of the district.

It is drought prone. Where rainfall may vary from 250 mm in the lowlands to 750 mm in the hill masses, most of this rain falls in a relatively brief period in two seasons: March/April and October/November. As a result, flash flooding is common when rainfall is good. Given an open-pan evaporation rate of approximately 2,000 mm per year, the general agricultural effect is dry-land farming with considerable variation in cropping success from year-to-year.

A combination of excessive livestock grazing with drought has denuded ground cover and contributed to soil erosion. This, combined with limited, variable rainfall, causes seasonal malnutrition in some households; periodic crop failures requiring famine relief are endemic to the district.<sup>2</sup> Some homes have shallow wells, but most dry up during periods of drought. Boreholes have not been particularly effective and salinity is a significant problem, especially in Mutomo and Mutha divisions in the southern part of Kitui. Therefore, alternative approaches to addressing water supply are strategic for food security, improved health and development initiatives in Kitui district.

Water is necessary for drinking, cooking food, washing and cleaning, growing plants, rearing livestock and serves as an input for many productive activities. Water is also central to food security, where food production, nutrition and health are closely woven together. Food insecurity tends to take one of two forms: 1) famines, with a significant increase in mortality; and 2) endemic (or chronic) malnutrition. Immediate symptoms of the latter include fatigue, increased morbidity and possible increases in mortality. It can be the product of deficient food intake (e.g., calories and protein), an imbalance in the diet (e.g., lack of essential vitamins and minerals), and a reduced capability to draw nutrition from food consumed. The latter is closely linked to water: consumption of enough water, quality of the water (e.g., diarrhoea), cleanliness and sanitation. Endemic malnutrition may occur seasonally, sometimes for a relatively brief period. Nonetheless, the impact can be powerful.

In general, food security has three essential elements:

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<sup>2</sup> The current drought with associated food insecurity is the fifth since 1970 (Muticon, 2002: 29).

- 1) Food production - In Africa generally, and in Kitui specifically, this is primarily the task of women. With limited access to resources and new knowledge, combined with periodic droughts, the provision of an adequate supply of food for household members is a daunting task. An element of being poor is a high risk aversion. Therefore, agricultural practices that might significantly increase output in normal years may be avoided because they have a lower likelihood of producing anything under adverse rainfall conditions. The use of livestock as a store of wealth, rather than a source of food and income, is another variation of being risk adverse.
- 2) Access to available food - Famines and endemic malnutrition are primarily the product of a loss of entitlement by a sub-set of the population, rather than food availability decline per se. Loss of entitlements tends to have specific gender impacts as able-bodied men generally eat first, while the elderly and youngest females eat what is left.
- 3) Nutritional security - This involves adequate protein, calories, micronutrients and minerals for all members of the household. This includes a range of variables from an ability to breast feed infants and time available to women to prepare quality food, to factors of cleanliness and sanitation within the household. Access to water, availability of water and quality of the water feature prominently in this dimension of food security.

In SASOL's *sand dam paradigm* extending and stabilizing water supply is central to realizing improved food security:

- water availability increases staple food production by expanding the growing season and enabling some food production when rains are minimal or fail completely, which, in turn, reduces a need for periodic famine relief;
- water enables the production of vegetables and some fruit, making possible a more balanced, healthier diet;
- increased water supply may facilitate expanded livestock production which contributes to land productivity as draught animals and through the provision of manure as well as expanding food supply in the form of milk and meat;
- accessible water sets women and girls free from extended hours of labour devoted to water collection for primary household needs, enabling girls to remain in school and providing women with new opportunities for productive activities in the community;
- an increase in water supply at household levels facilitates improved sanitation and overall cleanliness, hence reducing morbidity.
- better quality water for personal consumption reduces the incidence of diarrhoea, which increases the body's ability to absorb nutrients from food intake, increasing overall food security;
- A combination of the above plus potential cash crop production through selected irrigation will expand household income, enabling families to provide for their needs during emergencies such as drought as well as opening up opportunities for increased saving, investment and production.

The task of the assessment Team was to use the randomly selected set of 30 dams to test whether the sand dams constructed plus other complementary activities undertaken by SASOL were expanding the water supply available and, if yes, was the change in water supply having an effect on agricultural production, food security, health and other development-related issues listed above.

## **5.0 An Overview of Project Outputs**

The primary expected output of SASOL assisted projects was a sand dam. The purpose of this output is to expand the supply of water readily accessible to the community that constructs the sand dam.

## 5.1 Primary Project Outputs

A successful sand dam has three essential components: 1) a community-based site committee that takes the initiative to identify the stretch of a river where water storage would be most useful, oversees dam construction, including the mobilization of required labour and local resources, and coordinates community action to maintain a sand dam; 2) a concrete and stone re-enforced sub-surface structure placed at a strategic location within a stream bed; and 3) stream bed protection above the dam to limit soil erosion during the rains to allow the dam to accumulate the sand that will store water in an accessible manner. Of the first of these, only 27% of the site committees were still active at the time of the survey (see Table 2). 43% of the committees disbanded when the construction of the cement and stone barrier had been completed.

**If you do not  
repair the crack  
you will have to  
build a wall.**  
Swahili Proverb

For the second component, the results were distinctly positive: 83% of the dams constructed were functioning as intended (see table 2). For 13% of the dams a leak was reported and it was not clear that the members of the sand dam community had the expertise required to repair the leak. It is noteworthy that for the five dams that developed a leak the committees had been disbanded. One dam has failed, but this was the

product of bank erosion caused by a failure to provide plant cover to protect the bank.

On the key output, the availability of water, an impressive result is that 50% of the sand dams had water well into the dry season in the midst of a drought. An additional 13% had water but it was either too salty or too polluted for human consumption, so they failed to meet the basic objective of accessible, potable water. It takes a sand dam two to five years to mature with a significant accumulation of sand. Two sand dams without water were still maturing, so the ratio of dams with water in the midst of drought could rise to 70%. For the sand dams without water, the committees had either disbanded or were inactive. Similarly, for the dams with water unfit for human consumption the committees in each case had disbanded. For the three with salty water the decision to disband may well have been caused by the limited value to the community of the dam constructed.<sup>3</sup>

For the third condition, protecting the sand bank to limit erosion of silt into the dam, the results are mixed. Only 13% had both banks well protected with plant cover (see Table 2). Half of these had good accumulation of sand; half still had some silting. Three of the four had water at this time. 23% of the dams were filled with silt rather than sand; only one of these had plant cover on its banks, and that on one side only. The data do not show a direct correlation between an active site committee, plant cover to prevent silting and a good accumulation of sand.

**Table 2:** Primary Project Outputs Observed at 30 Sand Dam Sites

Dam	Sand Dam Committee	Dam Condition	Water Available	Sand Accumulation	Plant Cover on Banks
630	active		yes	some silting	No
701	inactive		yes	some silting	one side
702	active		yes	yes	one side
704	inactive		yes	some silting	one side
707	active		yes	yes	no
708	disbanded	leaking	yes	major silting	one side
709	inactive		yes	yes	no

<sup>3</sup> For the dam with seriously polluted water there were suggestions within the community that disbanding the committee was a deliberate act to enable the clan of the village elder to monopolize the use of the water to irrigate their land alongside the dam site.

711	active		yes	major silting	one side
713	active		yes	some silting	one side
716	active		yes	yes	yes
719	active		yes	some silting	one side
720	active		yes	maturing	yes
722	inactive		yes	yes	no
723	disbanded		yes	some silting	no
725	disbanded		yes	yes	yes
715	disbanded	leaking	yes**	some silting	one side
706	disbanded		yes*	some silting	no
714	disbanded	leaking	yes*	major silting	no
721	disbanded	leaking	yes*	maturing	one side
705	disbanded	failed	no	major silting	no
712	disbanded		no	yes	one side
718	disbanded		no	some silting	one side
726	inactive		no	some silting	yes
727	disbanded		no	major silting	no
728	inactive		no	maturing	one side
729	disbanded		no	major silting	no
730	inactive		no	yes	one side
801	inactive		no	maturing	no
802	inactive		no	major silting	no
803	disbanded		no	major silting	no
* Water was too salty for human consumption.					
** Water was too polluted for human consumption.					

## 5.2 Assessment of Project Output Performance

The primary intent of SASOL was to construct dams within stream beds. The technology was unproven and a credible number had to be built to achieve the demonstration effect for public acceptance. It was not SASOL's intent to organize and undertake a comprehensive development project in selected rural communities. Rather, the construction of a dam addressed a key constraint within a community - a lack of water - and it was SASOL's expectation that each sand dam community would utilize increased supplies of readily accessible water to advance development in their respective communities.

Community effort involved in constructing a sand dam was frequently described as "very hard" and "too much work". Given the time and effort involved, the sand dam must be seen as a major community investment.<sup>4</sup> As limited supplies of water are a major constraint in the area, community investment in a sand dam is essential for the wealth of that community. The time saved in collecting water represents a level of payoff that justifies this large investment by a community.

Therefore, the Team recommends that SASOL continue to construct sand dams as a priority output.<sup>5</sup> As will be demonstrated below, the development outcomes and impacts of sand

<sup>4</sup> SASOL's current estimates indicate an average dam contains KShs 269,570 of local resources and labour plus KShs 216,000 of inputs provided by SASOL.

<sup>5</sup> This conclusion is similar to that of the DFID-funded survey in the area: "The study established that the sand dam technology is suitable in socio-economic terms for provision of water in ASALs. It is

dams warrant SASOL's continued investment of resources in the promotion and construction of sand dams.

Given this intent and focus, SASOL has not invested significantly in follow-up training. Nor has it devoted staff time to do post-construction on-site visits to assess sand dam maturation and to encourage communities to persist in strategic activities to assure the development of a sand dam with accessible water of reasonable good quality. Donor evaluation and monitoring fostered this approach as no one funding arrangement exceeded three years. As sand dams take two to five years to mature, donors did not expect to observe outcomes or impacts. Their focus as well was on the primary output, the construction of a dam in a stream bed. To SASOL's credit, they have constructed some 400 dams and the vast majority are functioning well.

A weakness observed by the assessment Team is that not all of the dams constructed are maturing into a sand dam. The Team attributed this failure to three factors: 1) an inadequate understanding by community members of what constitutes a sand dam; 2) an inadequate sense of ownership of a dam by its community members; and 3) a failure to achieve community organization needed to maintain a sand dam. {For more detailed discussion see Annex B, sections 5 - 7 and Annex C, section 3.}

In some communities the members did not understand what a sand dam was. They were under the impression they were constructing a traditional dam designed to hold surface water. As a result, they were unaware that the realization of dam benefits was dependent on action to limit soil erosion and silting of the dam site to allow a dam to mature into a sand dam. Household members interviewed were asked whether there had been a successful transfer of water technology. 65% answered yes and of these 65% were in communities with sand dams that had water available suitable for human consumption {see Table 3 and Annex B, Table 18}. In contrast, 26% claimed the transfer of technology was only partially successful; 60% of these were in communities where the sand dams did not have water at the time of the interview.

**Table 3: Household's Perception of Success of Transfer of Sand Dam Technology (%)**

<b>Sand Dam Water Condition</b>	<b>Household's Perception</b>		
	Successful transfer	Partial - do not understand sand dam	Partial - failed to maintain sand dam
No water at this time	24	60	61
Water available	65	32	31
Unfit for human consumption	11	8	8
Total	100	100	100
Proportion of total sample	65	13	13

Sand dam technology has its roots in indigenous knowledge where a community understands that its water source of last resort is a scoop hole. Nonetheless, there is a need to build capacity within communities to understand the process through which sand accumulates to form a mature sand dam. For SASOL staff there also is a need to recognize that their message of what constitutes a sand dam generates outcomes only when the sand dam community acts on that message and advances the maturing of a sand dam. To build this capacity there needs to be a comprehensive training module on activities required for a

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easy to construct, operate and cheap to maintain. Its maintenance and operational needs meets the local expertise and resource endowment." (Muticon, 2002: vi).

dam to mature plus a monitoring and evaluation component that provides information on the application at the community level of that training module. Such a package will ensure continuous follow-up on the use of knowledge and skills, identification of gaps in the training process, and feedback that informs changes in the training module and training approach to fill these gaps.

These training results were not realized in all cases because capacity building extended by SASOL prior to and during dam construction was located at a sub-location level with only one or several persons from any one sand dam community participating. Therefore, the process required trainees to absorb and understand the training message, to transmit this message accurately to their respective communities, and then to mobilize community members to act on the message received. A breakdown in one or more of these three steps occurred in a number of communities. Hence this failure to comprehend what is a sand dam and what actions are required to maintain a sand dam. In 10% of the communities the claim was made that no training had been provided by SASOL. For this small minority, the message transmission from the capacity building process evidently broke down completely.<sup>6</sup>

Even in the cases where the community members understood the basic elements of a sand dam, 43% of the communities took no action to protect the banks to limit silting of the dam site (see Table 2). Only at 13% of the dam sites were both banks well protected with appropriate plant cover.

On the sense of ownership, in some communities members referred to their dam as SASOL's dam. In the case of a leak or if the pump broke down it was seen as SASOL's responsibility to repair these. This absence of a sense of community ownership of the dam affected adversely community willingness to act to assure a sand dam would mature or to limit contamination of the sand and the water in a well.

A failure to develop a sense of ownership may have been a product of covering inadequately the concept of a shared cost of dam construction in discussions between SASOL and the site committees involved. The villagers reflected a sense of being "told" what they were to contribute to access SASOL's inputs for dam construction. The value of the labour time of the people, the stones, sand and water collected, and the food and lodging provided did not carry a market price such as that for cement, re-enforcement bars and a *fundu's* salary. As a result, the villagers may have lacked a sense of having contributed significantly to the value of the dam, which, in turn, reduced their sense of ownership of the dam. An explicit costing of all inputs to the dam construction would focus attention on the magnitude of the community investment and highlight the important contribution of the community to the realization of this community asset.

Second, the Team also observed that the timing of dam construction affected the ability of the members of a community to participate in dam and well construction. Assuring that sand and stones have been collected and stones have been broken to size prior to the start of construction reduces the length of time required to construct a dam and opens the possibility of working in shifts rather than daily. Working out a construction schedule between SASOL and members of the community that recognizes competing labour needs during land preparation and planting and during harvest will increase the possibility of timely participation by all members of the sand dam community.

It is SASOL's intent that the approach to sand dam construction be a grassroots venture. The creation of a site committee and its integral role in the dam construction process is the

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<sup>6</sup> The need for training that covers "...more participants so as to impart greater sense of care and willingness to maintain the sand dams as well as addressing new needs" was flagged also in the DFID-funded survey (Muticon, 2002: vi).

means to this end. It is the Team's observation, though, that the process was perceived as top-down, at least in some sand dam communities. This perception by community members may have contributed to a failure in some communities to achieve a sense of ownership of their sand dam.

For most communities the point of entry was the Chief, the sub-Chief and then the village elder. The later convened a meeting and typically a site committee was struck from those community members who chose to attend that meeting. In a minority of cases this approach resulted in strong, representative committee members who coordinated dam construction well and remained active in maintaining the sand dam and related project activities. But, as reported above, 43% of the site committees disbanded after dam construction was complete; in another 30% of the communities the site committee was inactive at the time of the survey.

A related issue is the quality of leadership available and/or exercised within a sand dam community. In all cases where there was inadequate leadership within a community to deal with conflict the sand dams did not fill with sand,<sup>7</sup> nor did the dam contain water suitable for human consumption (see Table 4). In contrast, the accumulation of sand is highly correlated with the presence of dynamic leadership. The availability of water is related more generally to leadership, even if it lacked vision for the development potential of a sand dam.

**Table 4: Role of Community Leaders in Achieving a Productive Sand Dam (%)**

	Dynamic leadership	Good leaders but lacked vision	Community Conflict
Number of dams	8	13	4
<b>1. Condition of the sand in the sand dam (25 dams)</b>			
Dam has filled with sand	75	23	0
Considerable sand, some silting	12.5	54	25
Major problem of silting	12.5	23	75
	100	100	100
<b>2. Condition of the water in the sand dam (30 dams)</b>			
Number of dams	11	13	6
<b>2. Condition of the water in the sand dam (30 dams)</b>			
No water at present	36	31	50
Potable water for human use	64	62	0
Water contaminated or salty	0	8	50
	100	100	100

An important element in the exercise of leadership and community organization is the behaviour of the community members who own the land adjacent to the sand dam. The construction of the dam increased significantly the productive potential, and hence value, of this land. Where the process of dam construction proceeded on the basis of an agreement by these landowners to allow free access by sand dam community members to the water and sand in the sand dam, these agreements were verbal and they did not formally define the borders (banks) of the dam. Given this lack of definition it was not clear whether the land owners or the site committee had the right or the responsibility to maintain the plant cover on the banks to limit silting and allow a sand dam to mature. Where land owners became greedy, allowing silt to form in a dam site or to flow over sand that had accumulated, so they could farm the river bed, the sand dam did not mature nor

<sup>7</sup> The dams that were still maturing and the dam that failed were excluded, so the number of sand dams involved is 25.

perform as intended by SASOL. Where the landowners were cooperative, sand dam banks were much more likely to be protected. Also, some land owners rented land adjacent to the sand dam to community members allowing community members to grow vegetables there as well as facilitating community-based tree nurseries.

Leadership here is defined primarily by that provided by a village elder; secondarily the executive of the site committee. In several cases, the village elders who owned land adjacent to the sand dam were part of the problem in that they failed to limit soil erosion and they were using accumulated silt in the sand dam as agricultural land. In several other cases, the construction of several dams in the immediate area caused dynamic village elders to be a member of the neighbouring sand dam community and hence they were not directly involved in the construction and maintenance of the dam under assessment.

The Team recognizes fully the essential protocol of entry to a community must have the permission of and be facilitated by the Chief/elder system. Having gained that permission, the Team recommends that SASOL devote resources to work directly within a site to promote community participation and organization and to assure that sand dam community members understand building and operating a sand dam is more than constructing a concrete and stone barrier in a stream bed.

Accumulated SASOL experience demonstrates that building a sense of commitment and ownership of the construction project it is important to involve members of the sand dam community in decisions related to the development of a sand dam. Building this involvement starts with SASOL's point of entry to the community. This has taken the form of an initiative that comes from the members of a community who approach SASOL with a formal request to assess their water situation and to assist them in defining appropriate means to address the constraints represented by a limited supply of water. Alternatively, the point of entry was via a village elder to the members of the community.

The weak link in the process was the application of training at a sub-location level and then expecting the participants from any one site to transmit effectively the training received to the members of the sand dam community at that site. The Team recommends that SASOL employ participatory methods to build knowledge and understanding among community members at each site of what constitutes a sand dam and to obtain their commitment to undertake, jointly with SASOL, this major investment in a community asset. The content of such an understanding would include:

- 1) Direct involvement of the sand dam community in the decisions on whether to construct a dam and where to locate dam.
- 2) A detailed cost estimate of the proposed sand dam, including a monetary estimate of the community's inputs as well as the inputs supplied by SASOL.
- 3) Scheduling of dam construction in consultation with community members to assure their availability for the intensive, concentrated effort involved.
- 4) Selection of a committee with requisite skills and representative of the people in the sand dam community.
- 5) Recognize that constructing a dam is only a first step in sand dam construction. Focused effort to mobilize and supervise community action, similar to that required to build a dam, is needed to sustain the initial construction activity so a dam can mature into a functional sand dam with water for use by the sand dam community. As is the case for dam construction, a site committee representative of the sand dam community is required to assure this complementary activity is undertaken on a timely basis and in an appropriate manner. The role and responsibilities of this site committee need to be defined to assure that focus is directed to promoting technologies for sand dam maturation and shallow well construction.

An important factor in the failure to achieve the essential complementary activity for a mature sand dam is a lack of definition of what constitutes the “banks” of the sand dam. To address this it is recommended:

- 1) SASOL and the site community jointly define and mark the exterior boundaries of the sand dam banks as required to enable the constructed dam to mature into a sand dam. This may take the form of the Ministry of Water defining and marking the sand dam or it can be an agreement negotiated between the owners of the land adjacent to the proposed dam and the legal representatives – person(s) with signing authority – of the sand dam community.
- 2) Further, we recommend that the agreement between the adjacent land owners and the sand dam community be in writing, signed by the owners of the land and the legal representatives of the sand dam community. In addition to the standard provisions of permission to construct a dam and assured access of community members to the sand dam, the agreement should formally state the exterior boundaries of the sand dam banks as defined and marked in recommendation 1) above. This definition of boundaries should locate all responsibility for use and development within the boundaries to the sand dam community and define expected actions by the land owners for adjacent land beyond these boundaries as required to enable the constructed dam to mature into a sand dam.
- 3) The current SASOL practice of promoting napier grass as a combination of protective plant cover and livestock fodder is sound, provided the napier grass is maintained. Where the community and adjacent landowners are unable or unwilling to assure adequate plant cover is maintained it is recommend that bushes or shrubs be planted that are not eaten by animals and have no commercial value.

To guide SASOL’s involvement with the sand dam community after the completion of a dam it is recommended that SASOL put in place a system for monitoring and evaluation of project activities. This system would range from gathering relevant baseline information prior to dam construction to the documentation of project outcomes as defined in a project’s Logical Framework Analysis [LFA] (logframe).

A monitoring and evaluation system should promote participation by all stakeholders in all components of a project management cycle. The intent is to obtain joint reflection on project progress, identification of implementation gaps, a sharing of experience gained, and a process of joint planning that builds on experience gained to fill the gaps identified and to move the project forward to its intended purpose and goal.

## **6.0 The Outcomes Flowing from Project Outputs**

A flow of project outputs – community organization, sand dam, sand and water – in any one community is expected to generate a set of project outcomes within that community. A range of potential outcomes analysed in this assessment include:

- release of time from the chore of fetching water;
- increased agricultural output;
- further use of collective action and application of new technology;
- additional agricultural benefits;
- expanded business opportunities;
- increased household income; and
- improved food security.

### **6.1 Released Time from Fetching Water**

A well-functioning sand dam improves retention of ground water, which increases access to water and extends the supply of water into the dry season. This appears to occur in all

dams along catchments provided enough rain falls for water to flow, at least briefly, the length of the stream. An initial fear, that only sand dams in the upper reaches of a stream would be recharged, has not been borne out in practice.

The survey data show average time spent fetching water declined by 1.4 hours, from an average of 2.8 hours prior to dam construction to 1.4 hours currently. Focusing on the sand dams with water available for human consumption, the average time saved is 2.4 hours (see Table 5). As expected, it is in the communities where the sand dams do not have water where little time is saved fetching water.<sup>8</sup> This freeing of time, especially for women and girls, releases labour for the family as well as for agricultural production such as terracing, making compost and other actions to conserve the soil and increase crop yields.

The quantity of water collected increased on average by 47%; by 74% in communities with sand dams that had water available. Differences among the three water condition variables in the quantity of water collected per week prior to dam construction is statistically significant. The relatively small amount collected prior to the dam for households where community sand dams still had water is striking. The increased use of water by this subgroup suggests an appreciation for access to water may be a determining variable for developing and maintaining a productive sand dam.

**Table 5:** Average Time Saved Fetching Water and Quantity of Water Collected

Average Time Saved Fetching Water		Quantity of Water Collected (litres/week)	
Sand dam water condition		Past Week	Before Dam
No water at this time	0.38	670	549
Water available	2.35	639	367
Unfit for human consumption	0.65	641	461
Total sample (n = 187)	1.45	650	441
ANOVA F-statistic	22.88	0.16	8.17
Significance level	0.0%	85%	0.0%

## 6.2 Increased Agricultural Production

The combination of more water and more time opens up significant development potential. A primary area where these new opportunities express themselves is in agricultural production. {See Section 2 of Annex A for an extended discussion of this topic.}

As shown in Table 6, 55 per cent of the sample has invested part of the time saved in expanding agricultural activities. The increase is most evident for sand dams that have water, 77 and 42 per cent; for sand dams with no water only 27 per cent are investing in agriculture the small amount of time saved fetching water.

**Table 6: Time Saved Fetching Water Invested in Agriculture (per cent)**

Change in Labour Utilization	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
No change	73	23	58	45
Increase - agriculture activity	27	77	42	55
Total	100	100	100	

<sup>8</sup> The difference in the average time saved among the three water condition variables is statistically significant, based on an F-statistic for a one-way ANOVA.

Proportion of total sample	34	53	13	100
Chi-square test of this distribution, compared to expected distribution, is significant at the 0.0% level.				

The primary outcome of increased availability of water and more labour invested is the increased production of existing crops, primarily maize and beans in 25 and 20 per cent of the households respectively {see Annex A, Table A.2}. This increase in farm productivity is a product of women investing more time in soil preparation and in harvesting of crops. (Land preparation occurs during the dry season when most time is spent collecting water {see Annex A, Table A.2}). Water supply is also a factor with land in the bottom of the valley becoming more productive as the water table rises. For example, in selected areas maize was grown in the off-season where it could not be grown before.

There was a comparable expansion of production into new crops: vegetables 21 per cent and fruits 19 per cent. The primary crops involved were cowpeas, pigeon peas, pumpkins, mangoes, bananas and papaya. These changes were evident for the land owners adjacent to sand dams, by farmers or groups who have been granted access to or leased land near selected sand dam sites, and in some home gardens. With minor irrigation, tomatoes, onions and kale could be grown as well. Again, alternative use of time as well as increased supplies of water contributed to this change. For example, timely harvest of green grams reduces the risk of weevil infestation; timely harvest of cotton assures better quality and hence price; timely harvest of millet and sorghum limits destruction by birds and pests.

Increased livestock production was evident as well. Since construction of a sand dam 14% of the households had more cattle, 26% had more goats and 6% had increased their stock of other livestock {see Annex A, Table A.3}.<sup>9</sup> Prior to sand dams, in periods of severe drought, some animals died. Now, with the planting of grass to protect terraces and the banks of sand dams, the supply of fodder is increased. Also, animals do not have to walk as far to be watered and can be watered daily rather than every other day. Hence animals are less likely to die during a drought. Third, the effects of this saved energy and increased fodder supply is increased milk production and better quality animals - primarily goats - sold for meat.

### 6.3 Extension of Collective Action and Water Harvesting Technology

The sand dam represents a transfer of water harvesting technology that is appropriate to the physical conditions and social setting of a community. Specifically, overhead costs are low, maximum use is made of local materials, and the payoff becomes evident as early as the next harvest in the form of increased farm output and increased household income from farming and other activities. Also, given the effort involved, community cooperation and participation was required to construct this public good.

A potential outcome of communal effort to construct a sand dam is the extension of collective action to other forms of water harvesting technology. There are two reasons why such an outcome might be expected. First, the payoff in the form of increased supplies of water and a significant saving of time to collect the water from the sand dam construction experience was sufficiently large to motivate replication of communal action to other related activities. Second, to reduce soil erosion and to prevent a sand dam from filling with silt, SASOL's training emphasized the importance trenching, terracing and the planting of grass and trees. But these actions are themselves an important form of water harvesting. Indeed, it was reported in our survey that a combination of terracing, planting

<sup>9</sup> These numbers may understate the impact of sand dams on livestock production. Given the drought at the time of the survey, families reported they have been selling animals as part of their food security strategy.

of grass to protect terraces, and composting to obtain fertilizer that builds up the organic composition of the soil increased maize yields by 30%, beans by 25% and legumes by 23% {see Annex A section 2}.

Evidence of extending group activities within communities was limited, 22% (see Table 7). But, in communities with water suitable for human consumption, 35% of the interviewees reported an increase in group activities within the community.

**Table 7: Time Saved Fetching Water Invested in Group Activities (per cent)**

Change in Labour Utilization	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
No change	94	65	92	78
Increase in group activity	6	35	8	22
Total	100	100	100	
Proportion of total sample	34	53	13	100
The numbers in two cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

Similarly, the adoption of water harvesting technology innovations was low. Only 19% of the interviewees report they had constructed a private well and only 3% had constructed their own sand dam {see Annex A, Table A.15}. There were a few farmers who planted grass in gullies to slow the flow of water enough to grow bananas. Several farmers attempted to create mini-sand dams by piling sand bags at the bottom of gullies.

The adoption of terracing was more prominent: 65% of the households had well-maintained terraces while 18% had not terraced at all {see Annex A, Table A.10}. For the 65% with well-maintained terraces, 70% of these households reported some of the time saved from fetching water had been invested in terracing. For the planting of trees, only 14% of the households had a tree nursery. But, 53% of the households had planted a number of trees on their respective *shambas* (see Table 8). Only 16% of the households had not planted any trees. For the planting of many trees, the proportion rises substantially, to 73%, for households in communities with water available from their sand dam.

**Table 8: Household Adoption of Tree Nurseries and Planting of Trees (%)**

Adoption Rates	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
Tree nurseries				
No	97	81	95	86
Yes	3	19	5	14
Total	100	100	100	
Trees planted on <i>shamba</i>				
No	63	3	5	16
Yes, many trees	13	73	9	53
Yes, limited number	24	24	86	31
Proportion of total sample	34	53	13	100
The numbers in two cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

Finally, 15% of the households reported they had invested in donkeys to enable them to carry larger quantities of water to fields located some distance from the sand dam {see

Annex A, Table A.16}. This innovation opened up the possibility of growing some vegetables and maintaining a tree nursery even if one's *shamba* was not in the immediate vicinity of a sand dam.

#### **6.4 Additional Agricultural Production Opportunities**

As noted above, some of the time saved to fetch water was expended primarily on agricultural activities, including terracing of their farm land. Increased production is evident where terracing is combined with the planting of grass to protect the terraces, and composting to fertilize the soil and increase the organic content of the soil. The production effects decline where only one or two of these activities are undertaken

Of these three, terracing was the most evident. 52% of the households reported increased yields as a result of terracing; another 26% reported a wider range of crops could be grown {see Annex A, Section 2 and Table A.11}. This outcome was realized in a time of drought. It is to be expected it would be larger during years of average rainfall. These changes, when combined with agricultural output increases in the vicinity of sand dams, serve to increase both the supply and the variety of food available. Specifically, 63% of the households reported they were consuming more fruit and 68% reported consuming more vegetables when compared to consumption prior to sand dam construction {see Annex A, Table A1.14}.

The adoption of new water use technologies is not carrying over as yet to widespread adoption of improved farming techniques and practices. There was limited use of ridging and planting in rows, limited pursuit of new approaches to developing fodder for animals, limited use of improved varieties of seeds or evidence of knowledge of the preferred means and time for planting. Therefore, the Team concludes the effectiveness of training to promote agricultural production and achieving greater food security can be enhanced by emphasizing the importance of planting crops in rows along ridges, the potential of crop diversification, and the importance of crop rotation.

The addition of water from a well-managed dam opens a potential for diversification in crop production. Possibly because of the drought, increased diversification was not practiced widely. Where it was observed, the households were better able to provide for food security. When the rain fails, maize and bean crops fail. With a more diverse cropping pattern the risk of a total crop failure is reduced as crops like sorghum, millet, pigeon peas, cassava, etc., will survive.

Of particular concern is the lack of fodder, which constrains livestock production. This is being addressed partially by the planting of napier grass to protect the sand dam banks and the practice of some farmers to plant grass to maintain their terraces. The Team concludes that capacity building to encourage the planting of trees and shrubs suitable for fodder can augment the current supply of grass and fodder available. Therefore, the Team recommends that training designed to promote increased biodiversity should focus on trees and shrubs, e.g., lucerna species, which will provide fodder for livestock. As livestock form an important part in food coping strategies during drought, an increased supply of fodder will have food security impacts as well.

#### **6.5 Expanded Business Opportunities**

The availability of water and the freeing of time also spawned new business ventures {see Annex B, sub-section 2.3.2 and Annex C, sub-section 2.1 for an expanded discussion}. Survey results show 54% of the households reported an expansion of business activities in a form that provided increased employment opportunities (see Table 9). The primary activity of the community members is farming. In a number of communities with water available in the sand dam it was reported that young men had taken up vegetable growing. Establishing tree nurseries was another form evident in several communities with

substantial profits reported.<sup>10</sup> As we observe in Table 9, households in communities with sand dams that had water for household use were more likely to engage in some form of business activity (68%), primarily in farming-related business activities (52% versus 28% for the other two groups).

**Table 9: Households Expanding Farm and/or Business to Employ Labour (%)**

Adoption Rates	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
Tree nurseries				
No evidence	66	32	54	46
Yes, increased farming	26	52	29	41
Yes, brick-making	2	4	4	3
Yes, other form of business	6	12	13	10
Total	100	100	100	100
Proportion of total sample	34	53	13	100
The numbers in five cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

Brick-making as a business was reported in only 3% of the households. Brick-making served as both a source of income and an input for home construction. Even though it is not listed as a business activity, improved housing, drawing on water, sand and bricks available in a sand dam, was evident in many of the households visited.

Another form of business (10% of the households), included the marketing of increased supplies of fruits and vegetables made possible by a sand dam. This included setting up local road-side kiosks within the community, selling in markets in nearby towns as well as in Kitui town, and in one case selling in Nairobi. Given increased time, some women have also recognized an opportunity to buy fruit and vegetables in nearby markets and then selling them in their own communities. Women also were utilizing time saved to expand the practice of using sisal to weave baskets and ropes. Some were being sold others were for home use.

It should be noted that the increase in the supply of fruits and vegetables locally reduced pecuniary cost and time required to travel to the market for these food items. There is evidence that some of the money saved is being spent on more fruits and vegetables to be consumed within the household. The time saved is in addition to the factors listed above for time saved in the collection of water.

## 6.6 Increased Income for Sand Dam Community Households

As part of the survey we attempted to establish a household's income during the previous month from farming activities. On average, households reported monthly farm income of KShs 3,923 (see Table 10). Not surprisingly, farm income was lowest for households with one or more members wage employed, but the difference was not significantly different from the other two sub-groups. Also, in communities where the sand dam had water fit for human consumption households had an above average income (KShs 4,789). Again, differences among the three sub-groups were not significant.

<sup>10</sup> In several communities tree nurseries had been closed down because the supply of water had been exhausted.

For the other variables in Table 10 some caution must be exercised as the direction of causation is not known. Households may have higher income because of where they are located and changes they have made since the sand dam was constructed.

**Table 10: Average Household Income during Previous Month (KShs)**

Household Sub-group	Number of Households	Average Monthly Income	F-Statistic Level of Significance
Total sample	187	3,923	
Household location			<b>3.8%</b>
- Near sand dam site	60	<b>6,482</b>	
- Intermediate distance	58	<b>2,927</b>	
- Outer distance from dam	69	<b>2,534</b>	
Household income activities			42.5
- Farming only	95	4,806	
- Member(s) wage employed	73	2,875	
- Also engaged in business	18	3,727	
Water availability in sand dam			40.8
- No water	64	3,067	
- water available	99	4,789	
- water unfit for humans	24	2,627	
Increased income from:			
Expanded crop production	67	<b>8,775</b>	<b>0.0%</b>
Sale of fruit	24	6,580	14.1%
Sale of vegetables	46	<b>9,405</b>	<b>0.0%</b>
Sale of livestock	60	5,392	14.5%
Expanded business	66	<b>6,699</b>	<b>0.3%</b>
Numbers in bold indicate the observed differences are statistically significant. For household location it is differences among locations. For sources of income the difference in each case is from the average income of households that had not increased income through that particular means.			

Alternatively, it may have been the higher income households who had or obtained the resources required to expand household income in the manner shown. Increased household income generates increased savings and hence a capacity for increased investment. The increased income is the product of increased farm yields, expanding into new crops, extending agricultural production into the dry seasons and engaging in or expanded other commercial activities, e.g., brick making, construction, and retail selling. It is our expectation that the former explanation applies. If the alternative explanation does as well, this suggests the new opportunities presented by a sand dam have had an adverse effect on the distribution of income among households within a sand dam community.

Focusing on the outcome of new opportunities on average household income, we observe the households located in the immediate proximity of the dam have a significantly higher household income (KShs 6,482). Similarly, households that have increased income from selling vegetables (KShs 9,405), expanding crop production (KShs 8,775), and/or expanding business activities (KShs 6699) have significantly higher average incomes. These changes may be linked in that the households in the proximity of the sand dam were best able to draw on the water available to expand crop production, grow vegetables and engage in such commercial activities as selling vegetables, making and selling bricks, and profiting from tree nurseries. In general, it seems fair to conclude that possibly as many as half of the households have acted on water availability and time saving outputs of a sand dam to realize the outcome of increased household income.

## 6.7 Improved Food Security

The place of water in food security and the three essential elements of food security have been presented in section 4 above. Expected outcomes postulated there, with the exception of sanitation and health, were observed during this assessment as documented above. {For an expanded discussion of food security see Annex A, sub-sections 1.3, 2.1.3 to 2.1.5 and 2.2; Annex B, sub-sections 2.2 and 2.3.3.} We also observed that at the household level food security was defined primarily as access to two staple foods: maize and beans. It was observed that the one notable difference in consumption of these staples between the wet season and the dry season was a decline in the ratio of beans to maize from 1:2 to 0.25:2. Green pigeon peas, which were available at the time of the survey, especially in well-terraced fields, were being substituted for beans during this dry season.

As part of the assessment household members were asked about the impact of the sand dam and terracing on their food security: 21% said no effect, 50% said food security had improved as they now could produce and/or buy staple foods, and 29% said it improved food security when rains were adequate but not during the drought (see Table 11). In addition, they reported that during time of drought, when maize and beans cannot be grown readily, 88% were drawing on their own farm production as their primary food security coping strategy (see Table 11). The purchase of required food is made primarily from the sale of crops, vegetables and fruits, and livestock. Business income as a means to buy food was reported by 12% of the households, and was reported primarily by the 21% of the households who had not experienced improved food security since dam construction and the 26% of the households who had improved food security in the years when rains were adequate. Reliance on relief food as an element in food security coping was reported by 37% of the households. Its importance is relatively higher in those households for whom the community sand dam provided only partial food security, when rains were adequate. Drawing together this information from Table 11, the Team concludes achieving food security involves a strategic use of scarce water resources to produce specialty crops, including vegetables and fruits, to sustain livestock and to produce goods (e.g., brick-making), that command maximum quantities of maize and beans in market sales and exchanges.

**Table 11: Primary Food Security Coping Mechanisms and the Effect on Achieving Improved Food Security (%)**

Proportion Who Relied on One or More of These Food Security Coping Mechanism	Improved Household Food Security			
	No	Yes, produce and/or buy staple foods	Partial, if rains adequate	Total
Relief food	36	32	46	37
Own farm production	82	97	78	88
Stored Food	15	43	7	27
Purchased staple foods	97	93	98	95
- money from remittances	20	2	20	11
- from sale of crops	6	3	4	4
- from sale of livestock	3	0	6	2
- from business income	20	4	18	12
- some combination 1 to 4	49	83	49	67
Proportion of total sample	21	50	29	100

Comparing some of the characteristics of the households with changes in household security post sand dam construction we observe limited differences among the types of activities that formed primary sources of household income (see Table 12). Similarly differences among communities on the basis of water availability in the sand dam were not

statistically significant (see Table 12). The significant difference among households was in average farm income: KShs 6,739 for households able to improve food security through producing and buying food, KShs 976 for households with only a partial improvement in food security and KShs 1,214 for the 21% of the households who had experienced no improvement in food security since dam construction. The low average income for households with only partial improvement in food security for dam

**Table 12: Effect of Household Economic Activities and Water Availability on Greater Food Security (%)**

Household Activities	Improved Household Food Security		
	No	Yes, produce and/or buy staple foods	Partial, if rains adequate
Farming only	50	51	52
Member(s) wage employed	37	42	37
Also operate a business	13	7	11
Total	100	100	100
<b>Sand Dam Water Condition</b>			
No water at this time	33	31	41
Water available	51	61	41
Unfit for human consumption	16	9	18
Total	100	100	100
Proportion of total sample	21	50	29
The observed distributions are not significantly different from expected distributions.			

construction likely explains their relatively higher reliance on relief food and food bought from business income.

Given the importance of buying maize and beans during time of drought the changes in household food security subsequent to dam construction were compared with sources of increased income the households attributed to dam construction (see Table 13). The four important sources were increased crop production, expanded business activity, increased sale of livestock and the sale of vegetables. This ranking changes for the 21% of the households with no improvement in food security to expanded business activity, sale of livestock, increased crop production and sale of vegetables. For the 29% of the households with only partial improvement in food security the sale of livestock ranks first, then increased crop production, expanded business activity and sale of vegetables.

**Table 13: Sources of Increased Household Income and the Effect on Achieving Improved Food Security (%)**

Proportion Who Obtained Increased Income from One or More of These Sources	Improved Household Food Security			
	No	Yes, produce and/or buy staple foods	Partial, if rains adequate	Total
Increased crop production	8	56	22	36
Sale of livestock	13	40	32	32
Sale of vegetables	5	40	11	25
Sale of fruit	3	20	7	13
Sale of tree seedlings	0	16	4	9
Expanded business	26	49	19	35
Proportion of total sample	21	50	29	100

The use of water available from a sand dam to produce speciality food crops and fruits and vegetables has the advantages of a good nutritional supplement to the staple diet of maize and beans and they can be consumed in the event that adverse price shifts for fruits and vegetables, relative to that of maize and beans, makes market exchanges for maize and beans uneconomic. The partial substitution of pigeon peas for beans during the drought was noted above. In addition, 47% of the households reported having consumed fruits and vegetables the previous day. A number reported consuming tea with some milk for breakfast. Meat is consumed rarely, primarily during festivals.

The Team also observed that during this period of drought the households best able to buy maize and beans were those that had put into practice sound soil and water conservation practices {see Annex B, Tables 10 - 12}. The practice of such techniques was more evident some distance from streams and sand dams than on land nearer to water, reflecting the higher opportunity cost of fetching water and hence a greater appreciation of alternative water harvesting techniques. The importance these households attached to farm production as the means to food security is evident in their investing scarce resources in their farms rather than businesses.

Another area where changes in agriculture practice can improve food security is greater crop diversification. Possibly because of the drought, crop diversification was not evident widely at the time of the survey. Especially the production of fruits and vegetables allows sale at time of harvest to obtain needed cash for school fees and other expenses, reducing the need to sell maize and beans at a time when market prices are low. Further, in time of drought when maize and bean crops tend to fail, crops such as sorghum, millet, pigeon peas and cassava are more likely to survive as they are drought tolerant. Finally, factoring in grasses and shrubs, which can serve as fodder, as part of crop diversification enhances the place of livestock within a household's food security coping strategy.

Given the potential for change in this area the Team recommends the training offered by SASOL include the food security potential of diversification in crops grown, hence reducing the risk of total crop failure and increasing the range of food available at the household level. Food and nutrition training should incorporate a deliberate campaign to increase awareness of the nutritional value of indigenous foods and the new crops grown. The intent will be to ensure high-nutrition foods are not merely sold, but consumed as well. These foods can supplement the staple foods, maize and beans, improving the household basket of food intake and improving the nutritional and health status of the household members. Other crops that could be grown and included in the diet, given the increased water available, should be explored (e.g., soybeans, groundnuts, french beans and watermelons).

## **7.0 Realized and Potential Project Impacts**

The set of outcomes outlined above are generating some visible project impacts. We outline briefly here both the impacts observed during the assessment plus potential impacts that may be achieved with some adjustments to project inputs.

### **7.1 The Realization of Improved Nutrition**

The evidence collected on nutrition at the household level was limited to diseases that the lead female of the household could recall. A reduction in diseases was reported in only 5% of the households. For this small sub-set of the sample, 90% were located in communities with water available in the sand dam.

A limited impact of the sand dam on nutrition is in part the product that the team observed very few signs of malnutrition. This was supported by the Medical Director of the Mbitini Clinic in Mbitini. For each child to age 1 the clinic has monthly visit records. These provide the weight of the child and lists evidence of key nutrition related diseases: kwashiorkor,

marasmus, anemia, vitamin A deficiency and pellegra. Only 1 or 2 children per month (out of approximately 100) were significantly underweight. The Director reported some evidence of underweight in a few of the older children (age 1+), but the number that visited the clinic was small. Only the occasional case was diagnosed as malnutrition, and it was not clear that the incidence was any different now from that prior to the dams being constructed. In communities where vegetables and fruit were now more readily available village elders tended to claim community children were doing better in school. One elder, citing evidence from the local clinic, claimed improved performance was linked to fewer eyesight problems. This suggests there may have been a vitamin A deficiency in that community prior to the dam.

Interviewees were also asked to link eating changes to improvements in nutritional status of family members. Linking these responses to the question on improved food security, we observe 73% of the households claimed improved nutrition and listed own-grown production as a source for this improvement (see Table 14). Eating vegetables and fruit and consuming animal products (primarily eggs and milk) were listed for more than half of the households. Eating more regularly was listed as a source by only 37%, reflecting in part that 41% were eating three meals a day prior to dam construction.

**Table 14: Distribution of Sources of Improved Nutrition and the Evidence on Achieving Improved Food Security (%)**

Sources of Improved Nutrition	Improved Household Food Security			
	No	Yes, produce and/or buy staple foods	Partial, if rains adequate	Total
From own-grown food	46	86	69	73
From eat meals more regularly	15	54	22	37
Eating vegetables	49	83	56	68
Eating fruit	49	82	41	63
Eating animal products	46	70	41	57
Proportion of total sample	21	50	29	100

In general, it seems fair to conclude a combination of water harvesting activities, improved farming techniques, changes in nutrition, hygiene and other related practices, plus other development initiatives have served to eliminate severe forms of malnutrition in the communities observed. (This observation is not withstanding possible malnutrition that may become evident before the next harvest in early 2006, given the widespread effects of the current drought.)

## 7.2. Health Impacts of the Sand Dams

In general changes in the incidence of disease were small {see Annex B, Tables 15 and 16}. Diarrhoea, amoeba and malaria were mentioned most often. This observation is basically confirmed by the Medical Director of the Mbitini Clinic. They have recorded summary statistics for each day of the month and monthly totals for primary diseases. Diarrhoea is a significant problem, as is malaria and worms. Incidences of the latter two have remained much the same over the years. Malaria is severe from February into May, but not worse now than before the dams were built. It was the Director's observation that the primary health effect of increased water availability is fewer cases of skin ailments.

When asked to list ways in which increased consumption of fruits and vegetables had improved health (see Table 15), 42% of the households listed no change or worse health status (this includes families that had not increased consumption of fruit and vegetables).

Respondents tended to lump together the various form of improved health (39%). Greater immunity to disease (11%) and reduced malnutrition (6%) were singled out most often. These rankings remain similar among the three groupings on the basis of water availability with the exception that the group with no water in the sand dam are much more likely to report no change or worse.

**Table 15: Health Impacts of Increased Consumption of Fruits and Vegetables (%)**

Health Impacts	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
No change or worse	63	29	38	42
Reduced malnutrition	5	8	0	6
Greater immunity to disease	3	13	21	11
Children are more active	0	1	0	0.5
Improved school performance	3	3	0	3
Some combination of above 4	27	46	42	39
Proportion of total sample	34	53	13	100
The numbers in five cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

Household interviewees were also asked to list various aspects of more water and cleaner water that served to improve the health status of family members. Here 81% of the households considered health status to have improved (see Table 16). Again some

**Table 16: Determinants of Improved Health Status Because of Cleaner Water (%)**

Determinants of Change	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
No change or worse	36	7	25	19
More water to cook and clean	13	22	8	17
Better quality water	0	2	0	1
Combination of above 2	2	13	4	8
Boil water or use Water Guard	33	8	29	19
Combination of above 4	17	47	33	35
Proportion of total sample	34	53	13	100
The numbers in five cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

combination of the four factors was listed most often (35%). Boiling of water or use of Water Guard and availability of water were identified as the primary determinants of improved health. It is the communities with water fit for human consumption that are the least likely to say no change or worse (7%). More water available to clean and cook now rises to the top as the most important determinant of improved health.

Diseases related to water and sanitation can be prevented. An increase in the supply of water, when combined with the practice of safe hygiene - construction and use of pit latrines, a small jerrican with water next to the latrine for hand washing, more regular bathing, washing of household utensils, use of drying racks for dishes, and reduced contamination of the sand dam by humans and animals - can reduce significantly this set of diseases.

It was the Team's observation that improved health was a product of improved nutrition and access to a more dependable supply of better quality water. Benefits were observed to be more evident if construction of a sand dam was combined with adoption of latrine pits, boiling of drinking water and education on the causes of diseases.

Visible evidence of contamination of the sand and silt was observed in 60% of the sand dams. The important place of animals within the livelihoods of the people and the close proximity of such animals to the living space of the people implies the role of animals in contaminating the sand and water in a sand dam is not understood adequately at the household and community levels. Preventing animals from entering a sand step is a primary means to a cleaner source of water for household use.

The current practice of requiring animals to be watered below the dam is acceptable for a single dam. Where there are a series of dams in close proximity in the same stream bed it ceases to be practical. Experimentation with alternative animal watering systems is encouraged. Some examples may be a pump that lifts water into a communal trough outside of the sand dam or a pump that raises water to a holding tank from which animals can access water through individual drinking cups activated with pressure from the nose of the animal. The intent should be a watering system that is technically feasible to operate and maintain, is within the economic means of a community, and minimizes the spread of disease among animals.

Donkeys used to collect water represent a unique form of contamination. Women and children prefer to scoop water directly into jerricans strapped on the backs of donkeys. The provision of enclosed wells with a pump, with the well located outside the bank of a sand dam can reduce this form of contamination from animals.

Promoting community action to reduce contamination is recommended. Primary elements of such action are: separate places for livestock watering from places where people extract water for household use and construct pit latrines to prevent feces from being carried into the river during periods of rain.

Given that mature sand dams provide an increased supply of water at the household level for growing vegetables, cooking, drinking and washing, it is also recommended that capacity building to promote appropriate hygiene and sanitation practices should be emphasized to ensure this available water is not contaminated. If contamination occurs the incidence of water-related diseases will increase, affecting the nutrition status of the community. To facilitate evaluation and monitoring of training content and training effectiveness health and nutrition indicators should be included in baseline data collected.

### **7.3 Observed Changes in Gender Roles**

Women are a prominent part of the sand dam project. It is reported that 60% of the rural households in the project area are headed by women (Mutiso and Mutiso, 2004: 3). This ratio is similar to the 57% that was obtained in the DFID-funded survey (Muticon, 2002: 45). The ratio in our survey was much lower, 24%.<sup>11</sup> In the dam construction women on average provided 51% of the person-days of work invested. This ratio ranged from 25% to 80%. In the fetching of water women dominate. They are also the primary source of labour in agricultural production.

The survey provided limited evidence of project impact on changing gender roles {see Annex B, section 4}. Table 17 outlines the women serving in selected leadership positions

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<sup>11</sup> This difference likely reflects differences in how female-headed is defined rather than a significant bias in our sample. The differences in average farm income between male-headed and female-headed households was not statistically significant ( KShs 3,892 versus KShs 4,019 for the latter.)

within their respective sand dam communities: 13% had a female village elder, 6% of the construction committee chairpersons were women, 31% had a woman treasurer, and in another 27% there were two or more of these positions filled by a woman. It is of interest that women were less likely to be involved in these roles in the communities where water was unfit for human consumption (54% versus 23% for the total sample). Another anomaly is the high proportion of committees with a female treasurer in the communities without water in their sand dams (70% versus 31% for the total sample). For the communities with water, the proportion of committees with two or more positions filled by women is relatively high (40% versus 27% for the total sample].

Given the need to mobilize the community, a man was seen as more appropriate for the position of chair of the dam construction committee. Similarly, given the need for trust in the collecting, holding and spending money, a woman was preferred for the position of treasurer. The inclusion of both men and women on the committee created a democratic platform for decision-making and the active participation of women. Where women as well men had a voice in this democratic process opportunity was provided for all to participate in the construction of the sand dam, which, in turn, increased the community's sense of ownership of this major investment. This likely was a determining factor in why there was water available in some of the sand dam communities served by one or more female leaders.

Both on-site observation and anecdotal evidence received during our visit indicate the status of women in communities with active female leaders has been enhanced. Women are involved in both setting rules for the sand dam and applying and enforcing such rules. This exercise of authority with men and over men is providing the women with some confidence to become actively involved in other governance matters within their communities.

**Table 17:** Women in Leadership Positions in the Community (%)

Positions Held by Women	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
No evidence of involvement	8	24	54	23
Village elder	13	12	21	13
Committee chair	0	12	0	6
Committee treasurer	70	12	0	31
Combination of above 3	9	40	25	27
Proportion of total sample	34	53	13	100
The numbers in five cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

Another indicator of impact was evidence of changes in gender roles as a result of water being readily accessible in a community sand dam. The answer is basically no, with 71% of the interviewees reporting no change. The communities where water was available had a slightly higher proportion reporting a change had occurred (36% versus 29% for the sample total sample). The observed changes were primarily more children drawn into the fetching of water (21%). In only 6% of the interviews were men identified as having become more involved in this household chore.

**Table 18:** Change in Roles of Women and Children in the Collecting of Water (%)

Evidence of Involvement	Sand Dam Water Condition
-------------------------	--------------------------

	No water at this time	Water available	Unfit for human consumption	Total
No change reported	83	64	71	71
Men involved in fetching water	2	6	17	6
Children fetch some water	16	68	13	21
Combination of above 2	0	3	0	2
Proportion of total sample	34	53	13	100
The numbers in five cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

Women carry primary responsibility for water collection. The provision of cleaner, more accessible water improves the overall health of the women. Less energy is expended collecting water providing more time for agricultural activities, more timely preparation of meals, more time for group activities, and some time to relax. These changes, in turn, provided the additional impact of an improved capacity to address nutrition and health needs of household members.

On the issue of training, both men and women were selected to be trained in the sub-location capacity building sessions. We were not able to assess the relative impacts of training for men versus women.

#### **7.4 The Impact of Sand Dams on Children**

Water availability in a sand dam reduces the time children spend collecting water. This increases security in that girls no longer have to travel far to collect water and they do not have to collect water early in the morning or late in the evening {see Annex B, sub-section 2.3.6}. As a result they eat more meals, eat on a timely basis, they are able to spend more time with their family, and they have more time to attend school, which provides for a better education. Increased food production, especially fruit and vegetables, enables them to consume a greater variety of foods and improves their overall health and nutrition.

The interviewees were asked about changes in educational opportunities they had observed. 73% reported that they had not observed any change. This proportion was considerably lower, 59%, in the communities where the sand dams had water fit for human consumption. In that sub-set of communities 13% reported children had more time for school work, 13% observed increased enrollment and improved study, while another 11% identified improvements more generally. Therefore, if potable water is readily available there is some evidence of a positive impact on educational opportunities and schooling performance.

#### **7.5 Presence of Sand Dams Reduces A Need for Labour Out-migration**

It has been common practice that able-bodied men seek work elsewhere, especially in urban areas such as Thika, Nairobi, Mombasa and Kitui town. A combination of arable land constraints in Kitui district and limited non-farm employment makes it difficult for people, especially younger males, to obtain gainful employment within their own communities. For our sample, 16% of the households reported one or more family members had permanent employment elsewhere; another 24% reported family members were employed elsewhere as casual labour. These ratios were basically similar whether or not the community sand dam had water available. As we reported in Table 11, 11% of the household relied on remittances to purchase the food needed in time of drought. This proportion rose to 20% for the communities in which the sand dams had no water or the water was unfit for human consumption. {See Annex B, section 5 and Annex C, sub-section 2.2 for extended discussion of this subject.}

The possibility of enhanced social stability exists as the economic base of the community and the district expands. Within some of the sand dam communities we observed vegetable cultivation and brick-making. Others were employed as casual labour in local construction, trenching and terracing. Where these agriculture-related business opportunities were being pursued there was evidence of a reduced need for out-migration from those communities, especially by young men. This impact is still relatively small as 61% of the interviewees reported no change in the search for employment elsewhere since their sand dam was constructed. Again, this proportion did not vary much between communities with water in their sand dam relative to the other communities. Where increased local employment was occurring, at this early stage it was not possible to assess the impact of these changes in migration patterns on the social and economic stability of the community.

### 7.6 Demonstration Effect

An indicator of project success is the replication of project inputs and outputs in other communities. In our survey, 29% of the respondents reported people from other communities had visited their sand dam. An additional 32% reported that SASOL and other NGOs had brought people to see their dam. SASOL reports six other districts in Kenya have sent delegations to observe sand dams in Kitui District (Mutiso and Mutiso, 2004: 9). In addition delegations have been received from Ethiopia, Tanzania and Uganda, Rwanda, Zimbabwe and South Africa.

Visits to dam sites are not to be equated with replication. Nonetheless, SASOL reports that community leaders from Marsabit District have visited the site and sent artisans to learn construction skills (Mutiso and Mutiso, 2004: 14). In addition six other Districts have requested programs: Machakos, Makueni, Mwingi, Baringo, West Pokot and Turkana.

### 7.7 Awareness of How Water, Soil and Human Activities are Related

Individual farmers are engaged in specific soil and water conservation actions. When interviewees were asked about inter-relatedness among the primary elements - soil, water, vegetation, animals and humans - the majority claimed some awareness in specific aspects of their farming activities (see Tables 19 - 21). But, on-site observation on their *shambas* provided only limited evidence that they understood how these various elements were inter-related {see Annex A, sub-section 2.6}. Therefore, the Team concludes capacity building is still needed to develop an understanding of farming systems that conserve and utilize scarce resources on a sustainable basis.

**Table 19:** Evidence of Resource Inter-relatedness in Soil Conservation Practices (%)

Areas Where Inter-relatedness were observed	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
No evidence	6	9	13	8
Yes, in trenching/terracing	17	9	8	12
Yes, in grass and tree planting	3	14	17	11
Combination of above 2	74	68	62	69
Proportion of total sample	34	53	13	100

The numbers in five cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.

Specifically, current farming practices do not reflect the economic value of water within a farming system. There is no sense of channelling water to agricultural activities with the highest rate of return per litre of water utilized. Nor is there ready adoption of water conservation methods, e.g., drip irrigation and mulching. As a result, community action does not recognize a need to conserve scarce water supplies, especially in time of drought, to assure water will be available for human consumption and other essential uses of water.

**Table 20:** Evidence of Resource-interrelatedness in Water Harvesting Practices (%)

Areas Where Inter-relatedness were observed	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
No evidence	9	19	33	18
Yes, in trenching/terracing	75	64	54	66
Yes, water collection in cisterns	0	2	5	2
Combination of above 2	16	13	8	13
Yes, in other practices	0	2	0	1
Proportion of total sample	34	53	13	100
The numbers in seven cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

**Table 21:** Evidence of Resource Inter-relatedness in Improved Farming (%)

Areas Where Inter-relatedness were observed	Sand Dam Water Condition			
	No water at this time	Water available	Unfit for human consumption	Total
No evidence	41	28	37	34
Yes, in crop production	33	20	13	24
Yes, in vegetable growing	8	24	38	20
Yes, in livestock production	2	2	4	2
Some combination of above 3	16	26	8	20
Proportion of total sample	34	53	13	100
The numbers in five cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

Given that water is the constraining factor for farm households in Kitui District, the Team considers advancing such conservation methods as a priority. To this end the Team recommends:

- 1) Training that fosters conservation in the use of water will serve to reduce this constraint. Some examples include drip irrigation and the practice of mulching.
- 2) Training curriculum include material on how water, soil, vegetation and human activities are related. Expanding understanding among community members in this area will facilitate the process of the sand dam maturing, increase agricultural production, and contribute to obtaining and maintaining better water quality for the community.

## 7.8 Advancing Biodiversity

Increased biodiversity, in the form of a wider range of vegetation grown, was observed as an impact of changes facilitated by the combination of increased availability of water in sand dams, additional time that was saved in the collection of water, and the training provided by SASOL (and others). Only 21% of the households reported no evidence of an increase in the range of vegetation within their respective communities (see Table 22). This proportion increases to 36% for communities in which sand dams did not have water. The expanded range of vegetation was evident especially in trees, made possible by tree nurseries in some sand dam communities.

**Table 22:** Evidence of Increased Biodiversity (%)

<b>Areas Where Increased Biodiversity were Observed</b>	<b>Sand Dam Water Condition</b>			
	No water at this time	Water available	Unfit for human consumption	Total
No evidence	36	13	17	21
Yes, planting new varieties of trees and grass	42	41	46	42
Yes, in vegetable growing	5	16	25	13
Some combination of above 2	17	30	12	24
Proportion of total sample	34	53	13	100
The numbers in three cells were too small to apply a chi-square test to test whether this distribution, compared to expected distribution, was statistically significant.				

The claims made by interviewees were basically confirmed by on-site observation {see Annex A, sub-section 2.4 and Annex C, sub-section 2.3}. The availability of water enabled seedling production and the planting of seedlings earlier to enable tree growth to take full advantage of the rains. The increased growth of exotic trees for fruit, firewood, and commercial use of wood plus the planting of napier grass represent new and wider range of species in the area. Together they should increase soil fertility, offset deforestation, increase the local supply of fruit, and make fruit available locally at a lower cost. As these exotic trees tend to be vulnerable to termites, some offsetting action to deal with termites may be required.

A second form of increased biodiversity was becoming evident at dam sites where a higher water table within the stream bed and the immediate banks has generated a greening of indigenous plant species. During the dry season, especially in a drought year, trees would normally shed their leaves. Where there was ground water, this vegetation was still green. In some dam sites this growth was augmented by the planting of high water-demanding plants - bananas, arrowroot, and sugar cane. The recommended planting of shrubs for fodder would extend biodiversity further still.

## **8.0 Building for the Future**

Given the range and value of the project outcomes and impacts, as documented during this assessment mission, the Team has concluded that the joint investment by SASOL and the respective sand dam communities were resources well spent. Hence the recommendation that SASOL stay the course and continue with the construction of sand dams in Kitui district.

The Team also concluded that SASOL should now expand its mission beyond a focus on dam construction to invest more, in a relative sense, on community development and capacity building. The intend would be to build stronger community organization to enable sand dam communities to undertake public-good activities as required to facilitate and promote development - e.g., assure that sand dams mature as intended - and encourage members within the community to engage in private-good investments to improve water

harvesting, soil and water conservation, improved food security and health and expanded income earning opportunities. The proposal for an Information and Training Centre “to provide access to appropriate knowledge as a contribution to the development and innovation of the Kitui communities” (Vrienten, 2005), would be a concrete expression of such an expanded mission.

The broad outlines of the content of an expanded mission are provided already in sub-section 5.2 above. Building for the future the Team identifies several specific issues requiring attention (for detailed discussion of these issues see Annex B section 6 and Annex C section 3):

- 1) the training needs to be less concentrated and offered on a timely basis when sand dam communities are actually confronting the issues addressed within the training curriculum;
- 2) a ToT approach is sound, but the performance of persons trained needs to be monitored to assure they are active, they are communicating the training message received, and they have some ability to mobilize community responses to a training message; and
- 3) some attention be given to the content of training that builds experience to expand capacity to make effective use of new technology. This experience includes the search for, selection, adaptation and implementation of alternative technology as well as addressing issues such as expanding markets, access to credit, and acquiring requisite skills as required for investment in alternative technologies.

The team recognized that SASOL lacked the capacity to cover all aspects of training and capacity building for development that can build on the increased availability of water from a sand dam. Therefore, the Team encourages SASOL to be open to promoting and participating in collaboration and networking with Ministries and NGO’s active in the project area. Specifically, SASOL should: 1) confirm what others are doing so that they can link up with other agencies that can complement SASOL’s capacity building; 2) re-enforce the message where there is overlap in training curricula themes; and 3) fill in the gaps in the training being offered by the other agencies active in the project area. Finally, there is a need to harmonize the approaches of the various agencies working within the areas where SASOL is constructing sand dams.

The training message sought to use restricting access to the outputs of a sand dam or a well as a means to motivate participation in dam and well construction. The Team observed that this approach was not achieving the desired effect in a number of sand dam communities. Indeed, in some cases this has become a source of conflict within a community. Specifically, there is a need to recognize the contributions of households who participated initially, but withdrew for practical reasons such as a need to find food or to plant crops with the onset of the rains. A failure to do so will make it more difficult to promote cooperative activities in the future. This issue would be addressed partially with our earlier recommendation to schedule dam construction jointly with community members at a season that fits their abilities to deliver inputs and provide requisite food.

One of the observed outcomes was the production of vegetables in or alongside stream beds above a dam. The use of chemical pesticides and fertilizer for this production has the potential of depositing residues in the sand and water that may have long-term harmful affects {see Annex A, sub-section 2.7}. This needs to be monitored and appropriate knowledge on pesticide use will need to be extended to the farmers involved. The current practice of growing vegetables during the dry season serves to reduce the need for pest control. Promoting crop rotation within these vegetable gardens will also serve to minimize problems of pest infestation.

The potential harmful effect of chemical residues on fruit and vegetables also needs to be monitored. Farmers and consumers may not understand the recommended waiting period after spraying of chemicals before such fruit and vegetables are consumed as well as the

need to wash them. Similarly, the potential adverse health effects of long-term use of chlorine to purify drinking water are unknown and need to be monitored. Attempts to clean a well by pouring in chlorine can be dangerous.

Given a reported high salt content in the water in 10% of the sand dams suggests a potential payoff from some research on the actual chemical content of the water, methods of water collection that minimize the concentration of undesirable chemicals, methods of water use that might offset some of the adverse effects of this chemical content, and preferred ways to use such water productively. To this end the team recommends documenting the experience gained at dams with salt water to facilitate transfer of useful information among sand dam communities so affected (e.g., can it be used to irrigate certain crops and/or can it be used to irrigate most tree saplings and crops provided it does not come in contact with the leaves of the plants?).

The mature sand dams are increasing water supply in an accessible location. Having addressed supply issues, water quality now deserves some attention. The ability to monitor water quality and to promote cost-effective, sustainable approaches to minimize contamination and remove contaminants will require a means of water testing. Therefore, the Team recommends that the possibility of establishing such a water testing laboratory be explored, where water samples can be tested for a modest fee. This could take the form of encouraging the Ministry of Health, the Ministry of Water, or the private sector to provide such a facility. Alternatively, SASOL could expand its current elementary water testing facilities. The existence of a basic, accessible laboratory would facilitate SASOL's monitoring and evaluation of project implementation and, ultimately, would enable sand dam communities to obtain and maintain water quality suitable for the needs of their respective communities.

Finally, it was the Team's conclusion that an effective system of monitoring and evaluating the maturing of sand dams was not in place. This failure to monitor and evaluate community follow-up activities after the construction of a dam reduced the realization of the overall development impact of dam construction. In part this is a problem of previous donor funding arrangements. Given that funding was limited to a maximum of three years and given that a sand dam typically takes two to five years to mature, the project monitoring set out by donors was limited to outputs: number of dams build, numbers trained, and communities organized. As DFID monitoring documents show, these output targets were being realized during the life of the project. One indicator, 80% of the communities in the project area would have adequate water supply to last dry spells (United Kingdom 2002/2003), could not be measured. This assessment has shown that, at least in time of drought, this target is being met for 53% of the households. Assuming all dams still maturing have water available during dry spells, this ratio may increase to the mid 60%. In addition, were project planning documents made provision for collection of baseline data (SASOL, 2000), the relevant data required was limited to a set of project outputs.

Therefore, looking to the future, the Team recommends that specific outcomes and outputs, such as those analyzed in this report, be built into a project's log-frame [LFA]. As the gestation period for impacts may exceed the life of project funding, efforts should be made to identify verifiable indicators of the outcomes essential to the realization of planned project impacts. Appropriate baseline data should then be collected to enable measuring both quantitative and qualitative changes that can be linked to project inputs and outputs. To advance community ownership of project activities, where possible the community members should be drawn into the process of monitoring and evaluating project implementation.

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## Report Annex

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## Annex A

### **Kitui Sand Dam Socio-Economic Impacts and Outcomes from Changes in Agriculture Practices and Production**

by

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**September, 2005**

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## **1.0 Introduction**

### **1.1 Background Information**

Kitui district is a semi-arid area with a bimodal rainfall of 300 – 800 mm per annum. The rains fall in two distinct seasons: March - May and October - December. Geographically the district's topography is characterized by undulating land scenarios and a flat Yatta plateau. The altitude varies from 400 – 800 metres above sea level. The district is roughly 200 km from north to south and 120 km from east to west. It is classified ecologically under zone V and VI, where agricultural production is basically subsistence and where crops such as green grams, cowpeas, pigeon pea, millet, common bean and sorghum are grown. There is also agro-pastoral farming where crops together with animals such as small herds of cows (Boran cattle) and goats are kept.

### **1.2 Water Availability**

Water, being essential for life, is a major part of development input in Kitui district. The search for water is a significant preoccupation as there are only a few water sources such as seasonal rivers to serve them. These seasonal rivers flood during the wet season, only to dry up during the dry season. The sandy beds become important sources of water and of sand for construction purposes when the rivers run dry. Sources of water are usually rare and far apart during the dry season, hence distance to water source, frequency of water fetching trips and number of persons per trip vary between wet and dry seasons with a decrease in trips in the wet and increase in trips in the dry seasons. Water scarcity in this district is linked to a small amount of rain that is poorly distributed and erratic, excessive runoff, non-availability of permanent rivers, etc. This has led to poor economic development and food security as agriculture is a major source of income for most families

The low amount of rain in Kitui makes rain-fed crop farming a marginal and risky venture as, in most seasons, rains do not supply adequate moisture, especially at the reproductive stage of growth, to allow for any yields to be realized. The rainfall is characterized by torrents that last for a short duration resulting in losses in the catchments and little soil infiltration, hence low soil moisture content. The problem is made worse by high temperatures leading to high rates of evaporation and evapo-transpiration.

This has led to development of various ways of curbing the water problem such as wells, boreholes, water pans, earth dams, sand dams, etc. Wells and boreholes are extractive and deplete the existing aquifers. A better portion of them are dry and some of the existing ones are saline, especially in the southern parts of the district. Earth dams and pans require intensive and expensive equipment to realize. They are highly affected by silting with the process of distillation being equally expensive while they remain directly exposed to high evapo-transpiration rates. Sand dams harvest surface run-off for sub-surface storage where water is stored under sand and existing soil media.

These sand dams are impermeable structures constructed across ephemeral rivers mainly to impede surface water flow in the river-bed sand. This creates a higher water head which promotes a flow of water to the banks and in the river upstream from the dam. As result, there is an increase in the storage capacity of the river channel by accumulating the base flow and storing it in the sand. The kind of storage can last for a long time, up to the next dry season. Sand dams built in series interconnect this saturation and create a continuous aquifer in the river channel. The effect of this is bound to bring changes as will be discussed later in this report.

### **1.3 Agriculture**

Agricultural production forms a major part of livelihood for people in the Arid and Semi-Arid [ASAL] areas. This kind of production stretches from subsistence farming to agro-pastoral. This causes some of these communities to suffer during periods of inadequate or total rain

failure. SASOL's goal of providing water to these communities through sand dams has helped, not only to solve the water problem, but also to improve agriculture in these areas, where vegetable production and the varieties of fruits produced were minimal.

The survey has shown how important agriculture is: 88% of the households interviewed stated that they rely on own production as their food security coping mechanism (see Table A1). This, therefore, is an indication that if water problems in the ASAL areas (Kitui district) are addressed then there will be an improvement in food security as agricultural production improves. The main sources of income are related to availability of water and range from crop production, to livestock keeping, provision of casual labor in other people's farms, brick making, etc.

The aspects of agricultural production that are being addressed in this case are the growing of new crops that would result in increased crop production and income for the family. These include diversification in crop production as result of increased availability of water, changes in biodiversity where an increase in tree growing and especially fruits trees is featured, and an overall increase in growing trees which in this effect solves the problem of deforestation.

Finally, improved livestock production is assessed as a food security coping mechanism where the animals are sold to buy staple foods in the family, especially in the dry season, even though their prices tend to depreciate as the drought hits the community. This survey was done in the long dry season and showed most of the household members had sold most of their livestock to buy food as the short rains failed completely, resulting in a total failure of the staple crop maize and beans, while other crops like pigeon pea, millet, cassava, squash and cowpea survived with a low output.

The relationship between vegetation, soil, livestock water and human activities plays an important role in agricultural improvement, e.g., the freeing of women's time (human activity) affects the farm produce determined by proper land preparation and planting in time to utilize the available rain (soil and water). The filling of a dam with sand is affected by protection of the banks and digging of terraces, the relationship between human activity and water together with soil. This is best understood through the outcomes and impacts therein.

## **2.0 Socio-economic Impacts and Outcomes of Sand Dams**

### **2.1 Agricultural Production**

#### *2.1.1 Management of sand dam and agricultural production*

The primary change is the production of new crops - primarily vegetables plus fruit trees - by the land owners adjacent to the sand dam, by farmers or groups who have been granted access to or leased land near the dam site, and in some home gardens. There is evidence of new crops where 21% and 19% of the households had started growing vegetables and fruits respectively as result of availability of water (see Table A.2). Another 9% were planting more than before for these crops. For sand dams functioning well, 15% and 13% of the households were planting more vegetables and fruits respectively. These also come from the 48% of the households that made effective use of the new technology in crop production, i.e., new crops, including vegetables and fruits. The production of new crops is not only a provision of alternative sources of food but also a means to earn some income.

In addition, farm productivity is increasing as women invest time saved in collecting water in land preparation and harvesting of crops. (Land preparation and harvesting occurs during the dry season when most time is spent collecting water.) Crop production can be affected by later planting and harvesting. There was an overall increase in crop production

for the various crops investigated; these were maize, beans, legumes, vegetables, fruits and cash crops. The time saved utilized in farm work being 55% contributed partly to these increases (see Table A13); their causes of increase like terracing that will be discussed later. The reason being that production of a particular crop depends mostly on its management right from land preparation to harvesting. This being the case, freeing of time of women would then enable crops such as green grams, cotton, millet and sorghum, maize, beans, etc., to have a significant improvement in yield due to their proper management.

The women have enough time to concentrate on farm work (proper land preparation, early planting to utilize the unreliable little amount of rainfall available and reduction of pre-harvest losses that occur due to late harvesting). For example, timely harvest of green grams reduces the risk of weevil infestation with a 20% increase in yield realized by households that invested time saved in farm work, which includes the green grams; timely harvest of cotton assures better quality since it avoids cotton staining where out of the 55% time saved invested in farm; 7% and 4% of the households were growing new cash crops and had an increase in yield respectively and hence improved prices; timely harvest of millet and sorghum limits destruction by birds and pests though not reflected qualitatively was evident in some households whose time was freed as result of collecting water nearby. There was a 22% increase in the yield of maize out of the total increase as result of time saved. 64% of the time saved was reflected in the sand dams that were functioning well.

Finally, land in the bottom of the valley is becoming more productive as the water table rises, but this needs to be confirmed through hydrological study. Households located near the sand dam may have mentioned this but it does not mean the entire increase in yield would have been from the farm adjacent to the sand dam since it reflected the totality of the whole farm irrespective of its location. The vegetables and fruits growing at the sand dam were due to the availability of water for irrigation but not as result of rise in the water table.

### *2.1.2 Increased agricultural production*

Realization of project agricultural production impacts is dependent on two essential project outcomes: **availability of water from the sand dam** and **freeing of significant time (primarily for women)** from the regular task of fetching water. This then had improvement in yield for the mentioned crops: maize (25%), beans (20%), legumes (20%), vegetables (3%), fruits (2%) and cash crops (3%) (see Table A2). Vegetables, fruits and some cash crops may not have had a significant increase in yield since most of these were registered as new crops as earlier discussed.

The time saved tends to be expended primarily on agricultural activities, including terracing of their farm land where out of the 65% of the household that did terracing 70% of these were from time saved. The terracing contribution to increase in crop yield was maize (28%), beans (25%) and legumes (21%) where it was most significant unlike for vegetables, fruits and cash crops which were new crops grown.

Increased production is more evident where terracing is combined with the planting of grass to protect the terraces and composting to fertilize and increase the organic content of the soil. Reported increases as a product of these changes were: maize (30%), beans (25%) and legumes (23%). The production effects decline where only one or two of these activities are undertaken as seen in terracing above. It would be important, though, to conclude that terracing/trenching is the most significant of these in terms of increasing the crop production; the others only add up to make the yield better.

The fact that the potential of sand dam in increasing the yield and allowing the planting of new crops is realized even with the poor rains that have been there in Kitui district for the

last five years as indicated by many households from the qualitative data collected. It would be right then to say that with good rains the sand dams would actually improve crop production tremendously. This is also important since (56%) of the dams studied were built within this period of 2000 and 2004 when rainfall has failed in the district

The annual agricultural report for 2004 from the Ministry of Agriculture stated that crop production was generally poor due to the poor rainfall condition both in amounts and distribution. The weather was reported to be hot with poor rainfall condition. The other important aspect that seemed to affect this production is the proper understanding of relationship between water, soil, vegetation and human activities which will later be discussed. Table 1 shows the production aspects of various crops.

Table 1: Percentage Changes in Crop Production

<b>Crops grown</b>	<b>Maize</b>	<b>Beans</b>	<b>Legumes</b>	<b>Vegetables</b>	<b>Fruits</b>	<b>Cash crops</b>
<b>New crops</b>	1.1		6.4	20.7	18.6	5.3
<b>Expansion in production</b>			1.1	8.5	9.0	
<b>Increase in yield</b>	24.5	20.2	19.7	2.7	1.6	2.7
<b>New crop/expansion in production</b>			1.1	2.7	1.1	
<b>New crop/increase in yield</b>			0.5			
<b>No evidence of change</b>	74.5	79.8	71.3	65.4	69.7	92.0
<b>Total</b>	100	100	100	100	100	100

### 2.1.3 Potential for greater crop diversification

The addition of water from a well-managed dam opens the potential for diversification in crop production. Possibly because of the drought, increased diversification was not practiced widely. Where it was observed, the households were better able to provide for food security. This was observed best in the households that were growing vegetables and fruits and also those that were trained on utilization of the available resources done through intercropping and/or growing of various crops. As this is possible, it reduces the selling of staple crops to provide for other needs in the family where these staple crops do not even perform well as they are rain fed.

Vegetables and fruits come in as alternative sources of income and hence the staple crops do not have to be sold off early in the season when their prices are low. This will push over the provision of food for the family for a longer period during the dry season and hence not fall short of supply early when the rains are expected later in the season. When the rains fail, maize and bean crops fail. Families that were growing crops other than the staple crops had better meals for the family where the quantity of vegetables was high and that the meals were taken three times a day. This was not the case for the families without these crops. With a more diverse cropping pattern the risk of a total crop failure is reduced as crops like sorghum, millet, pigeon peas, cassava, etc., will survive and at least have a low output, as compared to total crop failure, since they are drought tolerant. The freeing

of time for the women definitely addresses this problem because from this study women proved to participate more in farm work than men.

The households that adopted the new technology in crop production through **changing** the farming techniques were 5%, an indication that the potential for improvement through adoption of better farming techniques is present and is bound to carry over with time if encouraged. This would reduce the dependency on staples such as maize and beans, which when planted in many cases fail. The availability of water causes an **improvement** in the farming practices and technologies in crop and vegetable production by 23% and 20% respectively (see Table A6). This occurred in the form of growing new crops, use of water harvesting techniques like terracing/trenches, and composting. Hence change lies in the improvement of these farming practices.

If families address crop diversification they will be able to store their staple food crops and use them at a time when the climatic conditions are extremely harsh, especially in the long dry season. This will mean that crops like vegetables and fruits, whose storage is a little bit difficult, will be consumed and/ or sold to cater for other needs in the family hence a reduction of price in the staple crops in the local market. This diversification will also ensure that there is no overflow of one type of crop in the market which may have an effect on the income of the farmer. This was seen from some households who tend to change and/or diversify the food coping mechanisms putting across competitive resources for the farmers' income.

Vegetables currently being grown are kales, tomatoes and onions. The scope of these can be widened to include other vegetables if the farmers are introduced to external markets without having to rely on the local market, which is limiting. This also applies to fruits, whose varieties have improved since dam construction enabling the availability of fruits in every season. Good quality fruits are an option as grafted mangoes, oranges, avocado, that grow faster and produce early, are currently available. Crops such as millet, sorghum, pigeon pea, cowpea, that are considered a poor man's diet, would very much assist in availing the staple food later in the season if planted and consumed in greater quantities than it is being done currently.

#### *2.1.4 Improved livestock production*

Prior to sand dams, in periods of severe drought, some animals died. Now, with the planting of grass to protect terraces and the banks of sand dams, the supply of fodder is increased. Also, animals do not have to walk as far to be watered and can be watered daily rather than every other day. Hence animals are less likely to die during drought. Also, the effects of this saved energy and increased fodder supply is increased milk production and better quality animals - primarily goats - sold for meat. The change in wealth as result of increased water was reflected in increased number of animals like goats, cows and other livestock were 26%, 13% and 6% respectively (see Table A3). This also enables several households to start keeping crossbreeds that were better in production than the indigenous breeds, especially for the goats and cows.

The increase in income as result of sale of livestock products and/or the livestock themselves was 32%, is an indicator of change. An increased amount of water was being used at the household as some of the households claimed to be watering their livestock at farms but not in the river. Goats had the highest percentage simply because of the fact that they were browsers and better at surviving in the harsh climatic condition where the cows are the first to suffer from this effect of drought as they die. The dominant vegetation, shrubs, also makes it possible for the goats to survive.

The use of livestock alone as food security coping mechanism may have not come out clearly because most households had a combination of crop production, livestock production, money from remittance and business to buy staple food. Sale of livestock

formed part of the coping strategy for 62% of the households interviewed. A reliance on one method to buy staple food is almost impossible in these areas. This is confirmed by the fact that the largest population of Kitui district is characterized by agro- pastoral but not merely livestock production alone.

Improved livestock production may have shown a small significant change simply because of the fact the advancing drought had forced a lot of families to sell off their animals to provide food for the family. Also, it is evident in most households that a combination of crop and livestock production was a source of income. Decreased grazing land, as result of increased population, decreased forest land due to deforestation, etc., has resulted in to many households not wanting to expand in livestock keeping, as reflected in this study when asked if they intended to expand livestock in the future.

#### *2.1.5 Planting trees for fodder*

Lack of pasture currently limits livestock production. Capacity building that encourages the planting of trees and shrubs suitable for fodder can augment the current supply of grass and fodder available. This will be more important especially in some of the tree species that farmers have planted on their farms like *Lucaena leucocephala*, *Moringa olifera*, etc., which the farmers are not aware that harvesting of their leaves could provide fodder for the livestock especially the goats. Acacia, which are indigenous tree species in these areas, also provide fodder for the livestock through their leaves and harvesting of the pods. These are some of the trees in the danger of being phased out due to the fact that it provides good quality charcoal.

Tree planting should not only concentrate on the planting of exotic trees but also indigenous trees such as these should be encouraged. Shrubs such as the tick berry a common weed in the ASAL areas should also be planted as it also provides fodder especially for the small animals (goats and sheep), introduction of other like *sesbania sesban* could also be put into consideration for not only does it provide fodder but is also a rich source of nitrogen if incorporated as green manure in the maize crop.

### **2.2 Role of Soil and Water Conservation in Achieving Food Security**

During this period of drought, the households best able to buy maize and beans were those that had put into practice sound soil and water conservation practices. The practice of such techniques was more evident some distance from streams and sand dams than on land nearer to water, reflecting the higher opportunity cost of fetching water and hence a greater appreciation of alternative water harvesting techniques. The importance these households attached to farm production as the means to food security is evident in their investing scarce resources in their farms rather than businesses.

The effective use of new technology into new activities for farming was 48%, an indication of the importance of farming as discussed earlier. Terracing as a soil and water conservation measures was measured as: 1) extensive and well maintained terraces (65%); 2) limited and poorly maintained terrace (17%); and 3) farms that did not have terraces (18%) (see Table A10). The impact of terraces/trenching on farm production was: 1) increased productivity of land (52%); 2) growing a wider range of crops as water is available longer in the soil (4%), 3) a combination of these two impacts (23%); and 4) no impact of terracing (22%) (see Table A11).

A relationship between the conservation measures and crop production established that 28% of the increase in maize was from the well maintained terraces while 22% for the poorly maintained terraces and 15% for those who did not have terraces. The increase in yield for beans was 25% for those with good terraces, 13% and 12% for those with poorly maintained terraces and those who did not have terraces. The increase in yield for legumes was 21% for the well maintained terraces while for poor terracing and places where there

were no terraces it was 19% and 15% respectively. The three crops were compared to terracing because the availability food in these areas is based on the availability of staple food maize and beans (including legumes). These show the value of soil and water conservation where increase in production is possible even with poor rains.

This becomes very important because most households claimed to have started terracing after the construction of the sand dam. The households trained by SASOL on the importance of terraces were 27%. There were other organizations that came in to train people in the community of which some started after dam construction. Most of these who had experienced an increase in yield had incorporated grass planting and composting which are important aspects if increase in yield has to be realized. The increase in availability of water encourages more soil and water conservation since the time saved is utilized in such activities which take place in the dry season.

### **2.3 Water Utilization**

Current farming practices are limiting in reflecting the economic value of water within a farming system. The channeling of water to agricultural activities with the highest rate of return per litre of water utilized is also limited. This is because the adoption of water conservation methods such as drip irrigation and mulching were reflected in few households. As a result, community action needs to recognize the importance to conserve scarce water supplies, especially in time of drought, to assure water will be available for human consumption and other essential uses of water in long dry season until the next rains.

The evidence of capacity to make effective use of new technology in changing farming practices was: new farming techniques (5%), new soil conservation practices (18%), new water use or water conservation practices (22%) and a combination of these three was (38%), while for no change in farming practices it was 17% (see Table A5). The adoption of new farming techniques was minimal an indication that even though the irrigation was practiced little was put into consideration by the dam community about economic use of water.

The percentage indicated by new water use and water conservation practices, which is 22%, was reflected more in new water uses as indicated by interrelatedness in the new farming practices where crop production (23%) and vegetable growing (20%) took preference over the other variables (see Table A6). An upsurge in new uses of water, based on economic uses of water, will enable expansion in crop both in size and time as seen in some households.

The increased amount of water used at the household level that was recorded per week in this study showed little evidence in terms of economic use of water for some of the households that had home gardens. Where irrigation practices were done by some of the households the water levels were high compared to the home garden being watered. Some of the households did not mention the use of mulches or the various economic methods of irrigation and yet they complained that the water could not sustain them till the next rainy season. At the sand dam there was minimal evidence of economic utilization of water, which needs to be encouraged to expand small-scale production of vegetable further to cater for food security. This would be confirmed best if the amount of water use is computed and compared to the output obtained from the piece of land under irrigation.

### **2.4 Vegetation and Increased Biodiversity**

Availability of water enables seedling production and the planting of seedlings earlier to enable tree growth to take full advantage of the rains. 14% of the households under study had tree nurseries while another 86% had none. The households with many trees were 53% while 31% had a limited number and another 16% evidenced lack of trees (see Table

A8). The increased growth of exotic trees for fruits, firewood, and commercial use of wood plus the planting of napier grass represent new and wider range of species in the area. Together they should increase soil fertility, offset deforestation, increase the local supply of fruit, and make fruit available locally at a lower cost. These would be best confirmed in the increased consumption of fruits throughout the year by the households under study since 63% had improved nutrition as result of eating fruits while 37% evidenced no improvement.

The value of planting grass and trees was seen in the various reasons given at the household level, i.e., 68% were acting on the awareness of these values while another 11% showed little evidence of action and 21% showed no action (see Table A9). The reasons for having the different exotic trees/grass species range from the need for grass as a livestock feed as it is planted on the terraces it enhances the ability of the these terraces to reduce the effect of soil erosion and hold water in the soil. The trees were more important in the fact that they provide timber, source of fuel (firewood), windbreaks and a few households said that they also provide manure in the soil through the decomposition of their leaves.

The exotic trees that were common *Grevillia* spp, umbrella tree, blue gum, *casuarina equisetifolia*, etc. These trees were either planted at the household compound or at the edges of the farm hence not affecting crop production in any way. Those in the farm itself were mostly fruit trees ranging from oranges, lemon, custard apple, guavas, mango, pawpaw, banana, avocado, tangerine and some indigenous fruit trees like tamarind, *zizyphus cuminii* and *azanza gackenia*. Although the planting of indigenous tree was not that wide should be encouraged. As these exotic trees tend to be vulnerable to termites, some offsetting action to deal with termites may be required.

At the dam site the vegetation was observed to be green as most of the indigenous trees at this time of the year when the study was done usually have already shed their leaves (long dry season). These showed that the sand dam increased the availability of water causing the greenness in these areas. There were also other crops that were high water demanding that the dam community said could not grow in this area but were seen to be performing well. These range from bananas, arrow roots and sugarcane that have become a common phenomenon in some of these sand dams. A study of change in vegetation as result of increased availability of water would best be able to confirm these findings.

## **2.5 Economic Benefits**

### *2.5.1 Increased supply of vegetables and fruits*

An increase in the local supply of fruits and vegetables reduces the monetary cost and time required to travel to the market for these food items. There is evidence that some of the money saved is being spent on more fruits and vegetables to be consumed within the household. This was seen in the increased consumption of fruits and vegetables compared to the planting of new crops. The consumption of fruits and vegetables was 63% and 68% respectively (see Table A14), compared to planting of new crops, which was 19% and 21%. The indication was that not all households that were consuming fruits and vegetables were growing them. This can be linked to information obtained from some of the households that the vegetables and fruits were more available now than before dam construction, especially during the long dry season, and that they did not have to travel to major towns to collect them as they were locally available. The time saved adds to the factor listed above for time saved in the collection of water.

### *2.5.2 Water availability and increased business opportunities*

The households under survey showed 35% had increased income from new or expanded businesses and 65% had no change in income since construction of a dam. The time saved utilized by women in new or expanded existing business was 27%, while 73% evidenced none (see Table A13). Evidence of capacity to make effective use of new technology by

expanding into new activities was 48%, 17% and 36% for farming, business and no evidence respectively (see Table A4).

Increased availability of water is generating some agriculture-related business opportunities. Young men were observed to be producing vegetables for sale locally and in surrounding markets. Road-side kiosks are emerging as places where fruit and vegetables can be bought and sold locally. Some women have taken up the purchase of fruit and vegetables in area markets and then re-selling these food items locally as indicated by the information obtained at household level. Similarly, local fruits and vegetables are being purchased by women and then re-sold in the larger area markets.

Given additional time available, some women are weaving baskets and making pots for sale. Brick-making for sale was also made possible by increased water supply in some villages where 3% had evidence of expanded activities to employ family labor in this. There were other business opportunities realized in some households like the sale of napier grass to those who have cows or the grass is provided for in exchange for labor during land preparation through ox-driven plough.

The concept of farming as a business had little impact due to the fact that most households showed evidence of effective use of new technology more in farming than in business. This kind of system where farming is only for food production tends to collapse in time of drought. It can be addressed for example through crop diversification as earlier discussed where the sand dams provide for this potential. There is need to change this concept of producing only for consumption in order to cater for food security.

## **2.6 Technology Adoption**

### *2.6.1 Sand dams as an inspiration for innovation at the household level*

There was limited evidence that people in selected households were experimenting with new ideas and technologies related to the potential for irrigation observed at a sand dam. For example, in a few places drip irrigation was observed. Some households were investing in donkeys to enable fetching more water as a means to irrigation in the home garden: decreased use of the donkeys (6%), increased use of donkeys to fetch water (15%), increased use of donkeys for other purposes (0.5%) and no evidence of change (78%) (see Table A16). This is proof that one does not have to be close to the dam to actually grow vegetables even though it requires one to have a donkey to carry the large amount of water.

A few farmers had planted grass in gullies to slow the flow of water so as to allow the growing of bananas. In other cases, sand bags were observed as a mini-sand dam on farms. Also, in two villages private sand dams were being constructed close to their homes. Similarly, there has been an increase in the number of private wells 19% had constructed one and 81% for the households did not have them (see Table A15). The duplication of the new technology of constructing a concrete wall across a stream as indicated above was 3% for those with mini private dams and 97% for those without.

This gives a reason that the technology can be easily adopted at the community level without having to use the material that SASOL uses for the actual construction of the sand dam itself. The use of sand bags, planting grass in gullies, among others, is the simple ways in which this technology can be utilized to trap water in the farms at the household level increasing the amount of water. This will enable the growing of new crops and also the increase in yields of the already existing ones.

The community members when asked about the cost of the sand dam claimed that it was too expensive to even want to put up their own. The few innovations by the various

households can serve to convince the community members of the use of this new technology to trap water in the farms that have small regression stream that point to the mainstream without having to use the materials that they claim are difficult to obtain due to financial constrains.

If these kind of innovation transverse through a large dam community group then the issue of total crop failure even with the minimal amount of rain that usually poorly distributed will be ruled out and this will go a long way in addressing the issue of food security.

### *2.6.2 The adoption of new farming practices*

The adoption of new water use technologies is not carrying over as yet to widespread adoption of improved farming techniques and practices. There was limited use of ridging and planting in rows (contour bunds), limited pursuit of new approaches to developing fodder for animals, etc. The households that had adopted the new technology in changing their farming techniques were 5%. The agricultural annual report for the year 2004 from Ministry of Agriculture indicated that the use of contour bunds which is a good water harvesting technology was limited among farmers.

This kind of a farming would enable the storage of water in the soil especially if the rains are not adequate enough especially at the reproductive stage. The effect of this would be low output amidst complete crop failure. This was evident in the households that were using this method and were able to harvest maize and pigeon pea when most claimed to have had a complete crop failure. The practice would work well with the various soil and water conservation methods as earlier discussed.

### *2.6.3 An understanding of resource inter-relatedness*

Individual farmers were engaged in specific soil and water conservation actions. But, there is limited evidence that they understand how the various factors - soil, water, vegetation, and human activities - are inter-related. As observed in most of the sand dams measures to enable the maturity of the dam were not seriously taken into consideration. For example, the planting of grass at the banks and the digging of terraces for farms adjacent to the dam was limited in some of the dams.

The use of compost that increases the conservation of soil moisture was evident in some households as it was seen as improvement of soil fertility and not a method of conserving water. Soils that have a considerable amount of compost are able to hold a high amount of water than those without.

The planting of many trees, which was high according to this study, reflect at a minimal level on their importance to enhancing the conservation of water due to the reason given above by the household for as to why they considered them important. Trees have the ability to reduce the excessive direct evaporation rates that are common in the ASAL areas. Planting of trees in the farm (agro-forestry) with species that do not compete with the crops for the available nutrients would enable the farmer to harvest even when the rains fail. Inclusion of these trees on the banks of the streams where the sand dam is constructed would also aid in the under ground water storage even though evapo-transpiration would be there. Capacity building is still needed to develop an understanding of farming systems that conserve and utilize scarce resources on a sustainable basis.

## **2.7 Water Quality**

### *2.7.1 The unique place of donkeys in the water system*

Donkeys used to collect water represent a unique form of contamination. Women and children prefer to scoop water directly into jerricans strapped on the backs of donkeys. The increase in the use of these donkeys to collect more water affects the quality of water

more. Some of the dams showed high rate of contamination especially where the scoop holes were being used since the animals would urinate and have their dung on the sand that infiltrated to the water stored in the sand.

The water available for household consumption and other uses (49%), household consumption (4%), water available but too contaminated for household use (3%) and water available but too salty for human consumption (10%) (see Table A18). The multipurpose use of water exposes water for human consumption to different sources of contamination and the fact that the dam community may not be aware of these dangers. Ways to reduce or even prevent contamination of water sources would come in hand to prevent water related diseases. The increasing amount of water from the sand dams multiplies the different water uses. The provision of enclosed wells with a pump, with the wells located outside the bank of a sand dam can reduce this form of contamination from animals as it is currently being done by SASOL.

### *2.7.2 Maintaining a supply of water for human consumption*

The use of chemical pesticides and fertilizer for vegetable production in stream beds or in the proximity of a sand dam may have long-term harmful effects especially if production is extended to meet external markets where the demand for good quality vegetables is high.

The current practice of growing vegetables during the dry season serves to reduce the need for pest control. Promoting crop rotation within these vegetable gardens will also serve to minimize a problem of pest infestation where one does not have to grow one type of vegetable but divides the plot into two or three sections depending on the size of the farm and grows different type of vegetables rotating them on these plots. This will even increase the variety of vegetables that one has for consumption and for sale. This system was well practiced by one of the farmers using sand dam water although it did not fall under this survey.

Alternative use of organic fertilizers will tend to address this problem because they are well decomposed in the soil and no residues left that could be easily washed away to the river. As such would be the use of compost manure. This needs to be monitored and appropriate knowledge on pesticide use will need to be extended to the farmers involved.

### *2.7.3 Monitoring adverse effects of chemicals on water and food*

The potential harmful effects of chemical residues on fruit and vegetables also need to be monitored. The farmers and consumers may not understand the recommended waiting period after spraying of chemicals before such fruit and vegetables are consumed and the need to wash them. Ways in which the use of chemical that have a residual effect may be reduced will tend to address this problem. The alternative use organic pesticides locally made by the farmers will also help if shown the various tree species that can be used. This if implemented early will be able to control the pest problems found in this crop.

Similarly, the potential adverse health effects of long-term use of chlorine to purify drinking water are unknown and need to be monitored. This becomes important because most dam community members were using chlorine to purify there drinking water with excuse that the availability of firewood for boiling drinking water was not there.

Chlorination of water as becomes an easy way out for cleaner drinking water. The amount and the duration for which the water should be left after chlorination may not be understood and this may pose danger to community members who may not understand this. Attempts to clean a well by pouring in chlorine can be dangerous. The problem of chlorination may well be solved if capacity building that expounds on the uses of chlorine in water is done. The exchange program that bring along Dutch student to do laboratory test

on water samples as part of their projects from various dams may help keep track on the various chemicals in the water hence SASOL is bound to find out if any problem occurs.

#### 2.7.4 Addressing the problem of high salt content in the water

Given a high salt content in the water in 10% of the sand dams suggests a potential payoff from some research on the actual chemical content of the water, methods of water collection that minimize the concentration of undesirable chemicals, methods of water use that might offset some of the adverse effects of this chemical content, and preferred ways to use such water productively. The concentration of such chemicals is high where the sand dam has a problem of silting as it holds a high amount of salt compared with sand. This salt content increases with the decreasing amount of water especially in the dry season. Mature dams do not have salt problem as they did before, e.g., in one of the sand dams Kiindu, Kwa Ndunda initially there was salt problem but now they claim that it is no longer there. The dam community said that the salt content in the catchments is reducing with years and that vegetable growing together with nursery tree seedling that was not possible is being done. The shallow well has high salt content than the scoop holes made in the sand and that the deeper the scoop holes the less the salt content.

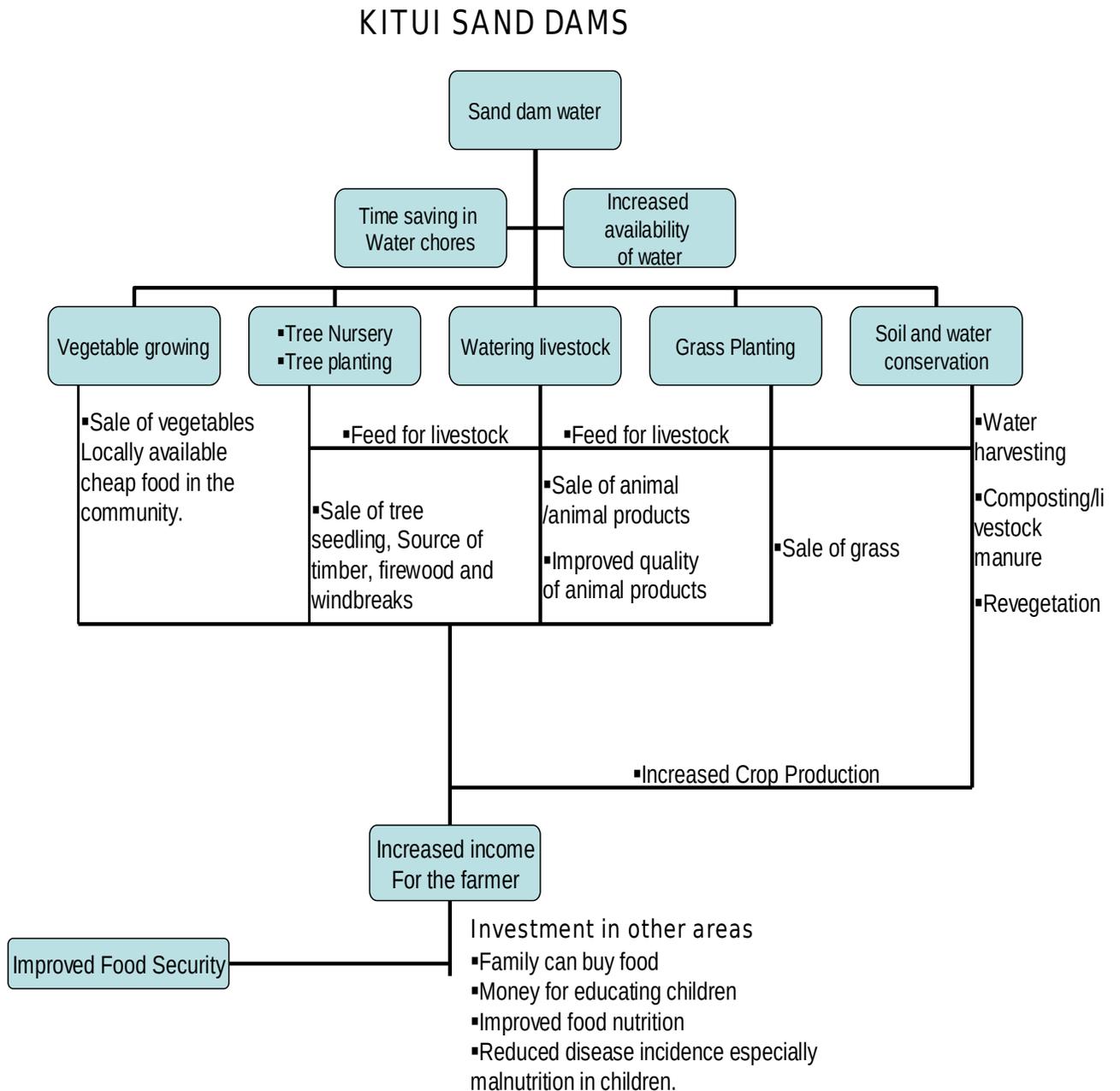
Documenting the experience gained at dams with salt water may also transfer useful information among sand dam communities so affected where such dam community members said that the salt content reduces as the dam fills in with sand and that over the years the salt content has been reducing due to the continuous flash flood during the rain period. The salt content if not too high as with some of the sand dam mentioned it can be used to water vegetables and tree seedlings as seen from one woman and some young men from the dam Syokaluvyu B.

### 3.0 Conclusion

The increased availability of water and time saving from water chores has brought improvement in Agricultural production in the ASAL areas. This forms the basis of livelihood for these people. This has improved the food security in the various aspects of food production and nutritional security and warrants SASOL to expand on the construction of more dams. The improvement in vegetation may bring along climatic changes leading to more of conventional rainfall and hence sustainable food resources.

#### 4.0: Summary of the Impacts of SASOL's Kitui Sand Dams

The impacts discussed above would be summarized as follows;



## 5.0 Tables of Data Used in the Analysis

Table A.1: Farm Production

	<b>Production</b>
<b>Not relying on agricultural production</b>	11.7%
<b>Relying on agricultural production</b>	88.3%
<b>Total</b>	100%

Table A.2: Crop Production

<b>Crops grown</b>	<b>Maize</b>	<b>Beans</b>	<b>Legumes</b>	<b>vegetables</b>	<b>fruits</b>	<b>Cash crops</b>
<b>New crops</b>	1.1%		6.4%	20.7%	18.6%	5.3%
<b>Expansion in production</b>			1.1%	8.5%	9.0%	
<b>Increase in yield</b>	24.5%	20.2%	19.7%	2.7%	1.6%	2.7%
<b>New crop/expansion in production</b>			1.1%	2.7%	1.1%	
<b>New crop/increase in yield</b>			0.5%			
<b>No evidence of change</b>	74.5%	79.8%	71.3%	65.4%	69.7%	92.0%
<b>Total</b>	100%	100%	100%	100%	100%	100%

Table A.3: livestock Production

	<b>Cows</b>	<b>Goats</b>	<b>Other livestock's</b>
<b>Change in wealth</b>	13.7%	25.5%	5.9%
<b>No change in wealth</b>	86.7%	74.5%	94.1%
<b>Total</b>	100%	100%	100%

Table A.4: Capacity to Use New Technology into New Activities

	<b>Activities</b>
<b>Farming related</b>	47.9%
<b>Business</b>	16.5%
<b>No evidence of change</b>	35.6%
<b>Total</b>	100%

**Table A.5: Capacity to Use New Technology in Farming**

	<b>Farming techniques</b>
<b>New farming techniques</b>	5.3%
<b>New soil conservation practices</b>	18.1%
<b>New water use/water conservation practices</b>	21.8%
<b>Some combination of the three</b>	38.3%
<b>No evidence of change</b>	16.5%
<b>Total</b>	100%

Table A.6: Improved Farming Practices and Technologies

	<b>Farm practices and technologies</b>
<b>Crop production</b>	23.4%
<b>Vegetable growing</b>	20.2%
<b>Livestock production</b>	2.1%
<b>Combination of the above</b>	19.7%
<b>Other practices</b>	0.5%
<b>No evidence of change</b>	34%
<b>Total</b>	100%

Table A.7: Capacity to Use New Technology in Crop Production

	<b>Crop production</b>
<b>New crops including vegetable &amp; fruits</b>	47.9%
<b>New varieties of existing crops</b>	5.9%
<b>Combination of the above</b>	5.9%
<b>No evidence of change</b>	40.4%
<b>Total</b>	100%

Table A.8: Increased Biodiversity

	<b>Tree planting</b>
<b>Many trees planted</b>	53.2%
<b>Limited number of trees</b>	30.9%
<b>No trees planted</b>	16.0%
<b>Total</b>	100%

Table A.9: Value of Planting Grass and Trees

	<b>Evidence of value</b>
<b>Acting on this awareness</b>	68.1%
<b>Little evidence of action</b>	11.2%
<b>No evidence</b>	20.7%
<b>Total</b>	100%

Table A.10: Soil and Water Conservation

	<b>Terracing</b>
<b>Extensive and well maintained</b>	64.9%
<b>Limited and poorly maintained</b>	17.0%
<b>No terracing</b>	18.1%
<b>Total</b>	100%

Table A.11: Impacts of Terracing

	<b>Impacts</b>
<b>Increased productivity of the land</b>	51.9%
<b>Grow wide range of crops</b>	3.7%
<b>Combination of the above</b>	22.7
<b>No terraces/trenches</b>	21.9%
<b>Total</b>	100%

Table A.12: Expansion in Farm/Business

	<b>Evidence of expansion</b>
<b>Increased crop production</b>	8.6%
<b>Vegetable production</b>	19.3%
<b>Livestock production</b>	1.1%
<b>Combination of the above</b>	11.2%
<b>Brick making</b>	3.2%
<b>Other form of business</b>	10.2%
<b>No evidence</b>	46.5%
<b>Total</b>	100%

Table A.13: Time Saved

<b>Time saved</b>	<b>Farm work</b>	<b>Business by women</b>
<b>Change</b>	55.3%	26.7%
<b>No change</b>	44.7%	73.3%
<b>Total</b>	100%	100%

Table A.14: Consumption of Fruits/Vegetables

<b>Improved nutrition</b>	<b>Fruits</b>	<b>Vegetables</b>
<b>Evidence</b>	63.3%	68.1%
<b>No evidence</b>	36.7%	31.9%
<b>Total</b>	100%	100%

Table A.15: Innovations

	<b>Private wells</b>	<b>Private sand dams</b>
<b>Present</b>	18.6%	3.2%
<b>None</b>	81.4%	96.8%
<b>Total</b>	100%	100%

Table A.16: Change in the Use of Donkey

	<b>Use of donkey</b>
<b>Reduced use as water is near</b>	5.9%
<b>Increased use to fetch more water</b>	15.4%
<b>Increased use for other purposes</b>	0.5%
<b>No evidence of change</b>	78.2%
<b>Total</b>	100%

Table A.17 Condition of the Sand Dam

	<b>Status</b>
<b>Dam is functioning well</b>	68.1%
<b>Dam has a leak</b>	14.4%
<b>Dam is still maturing</b>	13.3%
<b>Dam has failed</b>	4.3%
<b>Total</b>	100%

Table A.18: Condition of Water in the Sand Dam

<b>Water</b>	<b>Status</b>
<b>Household consumption</b>	4.3%
<b>Household consumption &amp; other uses</b>	48.9%
<b>Too contaminated for household use</b>	2.7%
<b>Too salty for human consumption</b>	10.1%
<b>No water in the dam at present</b>	34.0%
<b>Total</b>	100%

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**Annex B**

**The Process of Sand Dam Construction and the Effects  
on Food Security, Health,  
Gender Roles and Community Development**

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**September, 2005**

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## **1.0 Introduction**

### **1.1 The Kitui Sand Dams Project**

Safe Water is a basic requirement for human survival and good health. In Kenya a majority of the rural poor have no access to safe water and are dependent on any water source available within their reach. This exposes the community to diseases that could be controlled if there was enough water. The water situation is made worse by frequent drought that is common in some districts, especially those that lie in arid- and semi-arid lands. Kitui district, the district housing the project in question, is not an exception.

Kitui district is one of 12 districts in Eastern Province. The land area is 20,402 km<sup>2</sup> and the population exceeds 500,000. It is drought prone and a combination of excessive livestock grazing with drought has denuded ground cover and contributed to soil erosion. As a result, seasonal malnutrition is common in some households and periodic crop failures requiring famine relief are endemic to the district. Water is scarce and during the drought women walk more than 20 km to collect water. Water is normally carried in 20 litre containers on the back or on a donkey. According to UNICEF, a woman carrying a 20 litre container expends about 200 calories per hour. This has a negative impact on her health and nutrition. The high expenditure of energy, combined with inadequate food consumption due to the drought, affect the functioning of the household as women are the managers of the households. Considering this, water is essential if the families in rural Kenya, and Kitui in particular, are to continue functioning.

Addressing water supply is strategic for food security, improved health and development initiatives in Kitui district. To address the above problem, SASOL Foundation, an organization working with communities affected by severe water shortages in Kitui district with a number of years of experience, has perfected a sustainable system using technology that has become known as the sand dam paradigm. This paradigm is built on water as an entry point to development. Water is necessary for drinking, cooking food, washing and cleaning, growing plants, rearing livestock and serves as an input for many productive development activities. SASOL's place within this paradigm is that of a catalyst and facilitator. The community members define the problem, set priorities and make decisions that lead to solutions.

To date, approximately 370 dams have been constructed in Kitui. The area is said to have the highest concentration of sand dams in the world. It is assumed that construction of sand dams will allow an increase in water enabling communities to engage in more productive development activities that have a positive impact on them. Despite this assumption, the impact of the sand dam on the communities has not been documented. This then becomes difficult to strongly advocate for the sand dam paradigm or even to plan forward.

Mennonite Central Committee Kenya and Canadian Food Grains Bank are proposing to join in this investment. However, the only output clearly known to them is the existence of the sand dam. What happens to the community after the dam is in place still remains a mystery to them. To effectively participate in this venture, there is need to document the output, outcomes and the impacts of the sand dam. Hence the need for this study.

### **1.2 Purpose of the Study**

The purpose of this assessment study is to identify, verify and evaluate and document the outcomes and impacts that a sand dam has on the communities and use the findings to plan for a new phase.

### **1.3 Data Collection**

The primary source of data was on-site inspection, meeting with community leaders and interviews with selected household members who are resident there. An appropriate sampling technique was employed to enable generalization from selected dam sites to the set of sand dams completed as part of SASOL’s Kitui Sand Dams project.

For each set of villages selected for the field assessment the reference point was the completion of its sand dam. The data collected attempted to obtain a set of current observations and then to ask the respondents to compare this with what was the situation prior to the existence of the sand dam. Considering that some sand dam sites are more mature than others, a comparison of data from a number of dam sites enabled the team to document evolutionary changes that are occurring subsequent to the completion of a sand dam. Data was collected from 30 sampled sand dams and 187 sampled households served by the dams. After data collection a set of conclusion and recommendations were drawn by the team. This report will discuss some of these conclusions and recommendations.

## 2.0 Findings of the Study

As indicated above, data was collected from 30 sampled sand dams and 187 sampled households. To effectively discuss the impact that the dams has on the study population, it is important first to understand the characteristics of both the dams and the study population in question.

### 2.1 Characteristic of Study Population

#### 2.1.1. Characteristics of study population

The study households are mainly the residents of the villages served by the dam. On average each dam serves approximately 40 households. An appropriate sampling technique was employed that enabled both household that participated during the dam construction and those that did not participate, to participate in the study. The sampling technique also allowed households located near, Intermediate and far away from the dam site to be included in the study. The table below shows the location of the study households within the village in relationship to the dam site.

**Table 1:** Location of study households in a village in relation to the dam site

Household location	Frequency	Percent
Near dam site	60	32.1
Intermediate site from dam site	58	31.0
Far from dam site	69	36.9
Total	187	100.0

A total of 187 households were interviewed with an average of 6 households per each dam site. The respondents were mainly women (lead female) of the sampled households. 76% of the study households are male headed and only 24% are female headed. The average household size 7.3 Compare to the average household size of 4.4 for the Kenyan population (Kenya demographic and health survey 2003 central bureau of statistic Nairobi KENYA). 51% of the households do not have a member employed or having a business and are dependent on farm activities only, 39% have a member wage employed, 8% have a family business and the remaining 3% have a member employed and have a family business. Information collected established that majority of the household in Kitui depend on farm activities only. This emphasizes the importance of water especially during the dry season to ensure that households continue functioning. The table below shows the distribution of the household by sex of household head.

**Table 2: Distribution of households by sex of the head of the household**

Sex of head of household	Frequency	percent
Male	142	76
Female	45	24
TOTAL	187	100

**2.1.2. Distribution of study population by adults and children**

The study households have a total population of 1,368 persons 638 adults and 732 children. The study did not establish the age and level of education of the household members, but it established that 92% of the households had a child or children attending school and only 14% of the household did not have a child attending school. Of importance to note is that majority of the household members are standard eight graduates. There was evidence of early marriages for both girl child and the boy child. Cases of couples as young as 16 years for the girls and 17years for the boys were reported. It is however important to further establish the age most girls get married and level of education. Previous studies have established that there is a relationship between level of education and technology adoption. Considering that water harvesting is important for the household in Kitui, the low levels of education combined with early marriages. Low accumulation of wealth to facilitate effective participation during dam construction May limit the capacity of the community to understand and participate in the entire process of the sand dams, a result there will be limited realization of the full potential of the dams.

**2.1.3. The sand dams**

To date SASOL Foundation has constructed about 370 sand dams in Kitui district. For the purpose of the study, a total of 30 dams were sampled from 18 different catchments or streams mainly in Kitui central using random sampling as shown on Table 3 below. The table also shows the year of completion, height, length and volume and persons days in construction. The random sampling facilitated inclusion of dams that have matured and those that are still maturing. (A mature dam is that

**Table 3: List of randomly selected dams**

Catchment/ stream	Dam	Year complete d	Height in metres	Length in metres	Person days construction	
					Men	Wome n
Kisiio	K. mbwika	1997	1.95	20	42	127
Kisiio	Ndunguni A	1997	2.5	12	114	245
Kisiio	Mwetha	1997	2	20	278	216
Mwiwe	Ndia aimu	1998	1.7	43	612	856
Mwiwe	Kyanguni	1998	2.1	52	561	1,123
Kyeemukaa	Kalikuvu	2000	1.2	20	201	263
Kyeemukaa	Ndivuni	2000	1.9	17	87	97
Kyuusi	Kakumi	2002	2.8	36	174	411
Kwa Mbai	Silanga	2000	1.65	24	345	300
Mbusyani	K. Mwema	2000	1.85	36	217	214
Wii	K.Nzyani	1998	1.95	27	427	362
Wii	K.mukola	1998	2.1	27	66	66
Kyuusi	Kyamutala	2000	2.65	28	111	253
Ikindu	Kakunike B	1997	2.05	21	329	388
Ikindu	Ikindu	1999	1.8	25	117	299
Ithambaka	K. Kathata	2002	2.5	36	636	164
Ithambaka	Mwaniki 2	2002	2.5	26	113	79

Ethi	K. Kathenge	2002	1.3	37	539	270
Ethi	Syokaluvyu B	2001	2.35	28	542	101
Ngwani	Katiliku 1	2002	3.75	13	872	1080
Mavia matune	Kithimani	2002	1.85	22	329	225
Kiindu	K. Ndunda	1997	2.3	18	161	259
Mavia Matune	Kaukuni	2002	0.3	28	580	350
Kithiano	Kwakilonzo	2001	3.3	38	434	399
Yatta	K. Kasoa	2004	2.2	29	681	408
Nduni	K.kitoo	1996	2.1	15	423	252
Kithiano	Kivauni	2002	1.1	20	242	187
Yatta	Kwa-Wambua	2004	1.8	22	281	197
Kalikuvu	Kaluvu	2002	2.45	37	281	214
Muthungue	Muthungue A	2001	2.2	42	647	565
		Average	2.07	27	345	332

dam that has filled with sand as intended and has water available.) On each dam site there is a committee that supervised the dam construction. This committee is referred to as the sand dam construction committee. During the visit to the dam, this committee was also interviewed.

A comparison of data from these dams which are at different phases enabled the team to identify and document changes occurring at the community subsequent to the completion of a sand dam

#### 2.1.4. Status of the sand in the dam

During the study, it was established that sand dams constructed are at different phases of maturity. Maturity of the dam is dependent on the status/condition of the sand in the sand dam which is enhanced by the efforts of the community to implement complimentary activities that reduce the degree of silting and quicken the process of filling the dam with sand. The basic principle of the sand dam is that instead of storing water in the surface reservoirs, water is stored underground. By constructing a weir across the river bed, the sand carried by the flowing water during the rainy season settle in front of the weir and gradually the reservoir is filled with sand creating a sand bed. The stored sand improves retention of ground water which increases access to water and extends supply of water into the dry season. Considering the above principle, 33% of the dams have failed, 33% have considerable accumulation of sand and some silting, 23% have a major problem of silting, 13% are still maturing and only 27% are filled with sand as intended (see Table 4 below).

**Table 4: Status and condition of the sand in a dam**

status of sand in the sand dam	Frequenc y	Percent
Sand dam has failed	1	3.3
Sand dam has filled with sand has intended	8	26.7
Considerable accumulation of sand, some silting.	10	33.3
Major problem of silting	7	23.3
Dam still maturing	4	13.3
Total	30	100

#### 2.1.5. Condition of the water in the dam

Considering that the sand dam paradigm is built on water as an entry point to development, the availability of water in the sand dam is a must for the community to get involved in any meaningful development activities especially those that improve their food and nutrition security. The importance of water to the community is made more important by the fact that the rainfall received in this area is not adequate to sustain the rain fed agriculture making the situation worse especially during the short rains and the dry season that extends from January to October.

As stated earlier the main purpose of this assessment study is to identify, verify and evaluate the outcomes and impacts that a sand dam has on the communities. These outcomes and impacts are only realized if the dams have allowed increase in water. The study established that 53% of the dams have water for household consumption with 49% of these dams providing water for household consumption and other uses, 3% have water too contaminated for household use, 10% have water available but too salty for human consumption while the remaining 37% have no water at all. Majority of the dams without water were constructed between 2001 and 2004 and are still maturing. It is however interesting to note that one of the dams constructed in 2003 has water for both household consumption and other uses.

**Table 5: Status of water in a sand dam**

Status/condition of water in sand dam	Frequency	Percent
No water in sand dam at present	64	34.2
Water available for household consumption	8	4.3
Water available for household consumption and other uses	91	48.7
Water available but too contaminated for household use	5	2.7
Water available but too salty for human consumption	19	10.2
Total	187	100.0

#### 2.1.6. Presence and nature of the community well

The safety of the water used by the household for cooking, drinking and washing depends largely on the ability of the community to ensure that water is not contaminated from the source. To achieve this, one other important output of the sand dam project is construction of an enclosed well with a pump adjacent to the sand dam. On site visits revealed that not all dams have wells in place and that the wells present are different in nature. 57% of the dams, serving 56% of the study households, are without a well and have scoop holes only, 17% of the dams, serving 21% of the study households, have an open community well, 10% of the dams serving 9% of the study household have an enclosed community well and only 17% of the dams serving 14% of the study households have enclosed community well with a pump.

#### 2.1.7. Status of dam construction committee

One of the essential outputs of the paradigm is the formation of the committee to maintain the sand dam and wells, manage drainage into and drawing of water from the sand dam area and to mobilize community action for complimentary water harvesting, agricultural and environmental activities that ensures maturity of the dam and repair and maintenance of the water structures. Out of the 30 dams studied, 37% of the dams had their committee disbanded after the dam construction, 37% of the dams have committee existing but have limited impact and only 27% have active committee in existence. Considering the above information, 73% of the dams have committee that is not active or has limited impact. This affects the post dam construction management of the sand dam and the well. This is

confirmed by the interviews and observations during the onsite visit. Information collected established that, 63 % of the dams are functioning well, 13% of the dams are leaking, and 20% of the dams are still maturing while one of the dams studied has failed completely. On wanting to establish the way forward for the dams, there was little evidence of the community's capacity and enthusiasm to repair the dam that were leaking and facilitate the maturity of the dams that were still maturing while there were no plans to rehabilitate the dam that has completely failed. The status of the dams re-emphasizes the importance of post dam construction sand dam management committee to ensure that the water structured are properly maintained, and that community facilitates the maturity of the dams.

## **2.2 Impact of Sand Dam on Food Security**

### *2.2.1. Increased supply of fruit and vegetables.*

Before dam construction, households interviewed reported that during the dry season, as it was during the study, fruits and vegetables were completely absent in the diet among the majority of the households in Kitui as only a few members of the community were able to pay cost of fruits and vegetables from the local markets or travel to Kitui market to purchase the same. On wanting to establish the type and source of fruits vegetables supply before the dam, it was reported that fruits and vegetables were supplied from the neighboring Thika and Nyeri districts of central province and Meru and Embu districts of Eastern province. Local fruits and vegetables vendors bought vegetables from the market and re-sold the same in the local village markets. The cost of transport from the source was reflected in cost of fruits and vegetables reducing the ability of the households to access these essential food items. Sukumawiki (kales), cabbages and tomatoes were the most common vegetables supplied to markets in Kitui while fruits comprised mostly of bananas and avocados. It is also important to note that vegetables were scarce during the drought when majority of the households could not even meet the family needs of the staple food of maize and beans little money available for food was then used to purchase maize and beans denying the household members access to fruits and vegetables.

The dams constructed have allowed an increase in water, leading to production of more fruits and vegetables. This has increased local supply of fruits and vegetables making it possible for balanced healthier diet by both household producing fruits and vegetables and those that are not producing. Vegetables produced by majority of the households include Sukumawiki (kales) and tomatoes, a few household grow onions and spinach while one household was growing maize under irrigation. Fruit trees grown include oranges, bananas, custard apple, guavas, loquats, lemons, avocado and pawpaw. It is important to note that there is evidence of increased number of households growing fruits and vegetables irrespective of the location of the household from the dam site. Young men are producing vegetables for sale locally and in surrounding markets in the *shamba* near the dam site while women who are far and intermediate between the dams grow fruits and vegetables at home. Donkeys are used to collect water for watering the fruit trees and vegetables.

Increased in supply of fruits and vegetables as result of the project, is confirmed by correlating increase production of fruits and vegetables and condition of water in the dam. Of the 34 % of total study households that reported change in vegetables production either in growing vegetables now not grown before or increased in production/planting more than before, 21% are served by dams with water available for both household consumption and other uses, 5% are served by dams with water available for household consumption, and the remaining 8% are served by the other dams. It is important to note that production of fruits and vegetables is not influenced by the location of the household within the village but by the condition of the water in the dam. As a result, an increase in water will lead to increased production of fruits and vegetables among the entire household served by the dam.

Productions of fruits follow the same trend as vegetables. Out of 34% of the total study household producing fruits, 18% are served by dams with water available for both household consumption and other uses, 6% are served by dams with no water the remaining 10% are served by other dams. It is interesting to note those households served by the dam with water too salty for human consumption are also growing both fruits and vegetables. One of the farmers reported that water was safe for both fruit trees and vegetables if water does not sprinkle on the leaves when watering. The innovation of these farmers needs further exploration and sharing with other farmers to enable them use the salty water. The table below shows the percent number of household served by the various dams producing fruits.

**Table 6: Households producing vegetables in relationship to water condition (%)**

Dam condition	Output of vegetables as result of the dam					
	No change before and after the dam	Vegetables grown now not grown before	Planting more vegetables than before	Increased vegetable yields	Increased yield, planting more than before	% of the household within the total study households
No water in the sand dam	27.8%	4.3%	1.1%	0.5%	0.5%	34.2%
Water available for household consumption	2.1%	1.6%	0.5%	0%	0%	4.3%
Water available for household consumption and other uses	27.8%	12.8%	4.3%	1.6%	2.1%	48.7%
Water available but too contaminated for household use	2.1%	0%	0.5%	0%	0%	2.7%
Water available but too salty for human consumption	5.9%	1.6%	2.1%	0.5%	0%	10.2%
Total	65.8%	20.3%	8.6%	2.7%	2.7%	100%

**Table 7: Percent of household producing fruits in relationship to condition water condition**

Dam condition	Output of fruits as result of the dam					
	No change before and after the dam	Fruits grown now not grown before	Planting more fruits than before	Increased fruits yields	Increased yield, planting more than before	% of the household within the total study households

No water in the sand dam (count)	50	9	5	0	0	64
% of the household within the total study households	26.7%	4.8%	2.7%	0%	0%	34.2%
Water available for household consumption (count)	6	1	1	0	0	8
% of the household within the total study households	3.2%	0.5%	0.5%	0%	0%	4.3%
Water available for household consumption and other uses	57	22	7	3	2	91
% of the household within the total study households	30.5%	11.8%	3.7%	1.6%	1.1%	48.7%
Water available but too contaminated for household use	4	1	0	0	0	5
% of the household within the total study households	2.1%	0.5%	0%	0%	0%	2.7%
Water available but too salty for human consumption	13	2	4	0	0	19
% of the household within the total study households	7%	1.1%	2.1%	0%	0%	10.2%
Total count	130	35	17	3	2	187
% of the household within the total study households	69.5%	18.7%	9.1%	1.6%	1.1%	100%

### *2.2.2. Trade in fruits and vegetables*

Increased production of fruits and vegetables has led to start-up of road side kiosks where fruits and vegetables are sold locally. During the study it was established that both women and some young men have taken up the purchase of fruits and vegetables from household producing and the market places and re-selling these food items locally.

Information collected revealed that 3% and 2% of the total study household had increase in income from sale of fruits and vegetables respectively despite having not reported any change in production of fruits and vegetables after the dam. Increase in income could be explained as trade in fruits and vegetables bought from the households producing or markets and re-sold in the local kiosks. Local trade in fruits and vegetables has saved women both time and money use to travel to Kitui market. Availability of fruits and vegetables locally has increased the purchasing power of households making fruits and vegetables accessible to households not producing these food items. The study shows that 40% of the households that did not report any change in vegetable production consumed vegetables in the reference day- yesterday while 38% consumed fruits the reference day- yesterday..

### *2.2.3. Consumption of fruits and vegetables*

To establish consumption of fruits and vegetables at the household level, respondents were asked to recall the meals prepared and consumed by the household members yesterday. 47% of the households reported having consumed both fruits and vegetables yesterday, 21% consumed vegetables alone, 17% consumed fruits alone and only 16% of the household did not consumed either fruits or vegetables the day in question. This does not rule out consumption of fruits and vegetable other days of the week. A majority of the households reported including vegetables in about 4 family meals in a week while others reported that children consumed fruits any time of the day but they did not keep track. Consumption of indigenous fruit was also evident; fruits consumed include tamarinds indicus and 'MATOO'. The nutritive value of the indigenous fruits cannot be underscored as most of them have medicinal value.

### *2.2.4. Distribution of household producing/consuming fruits and vegetables within the village in relationship to the dam site*

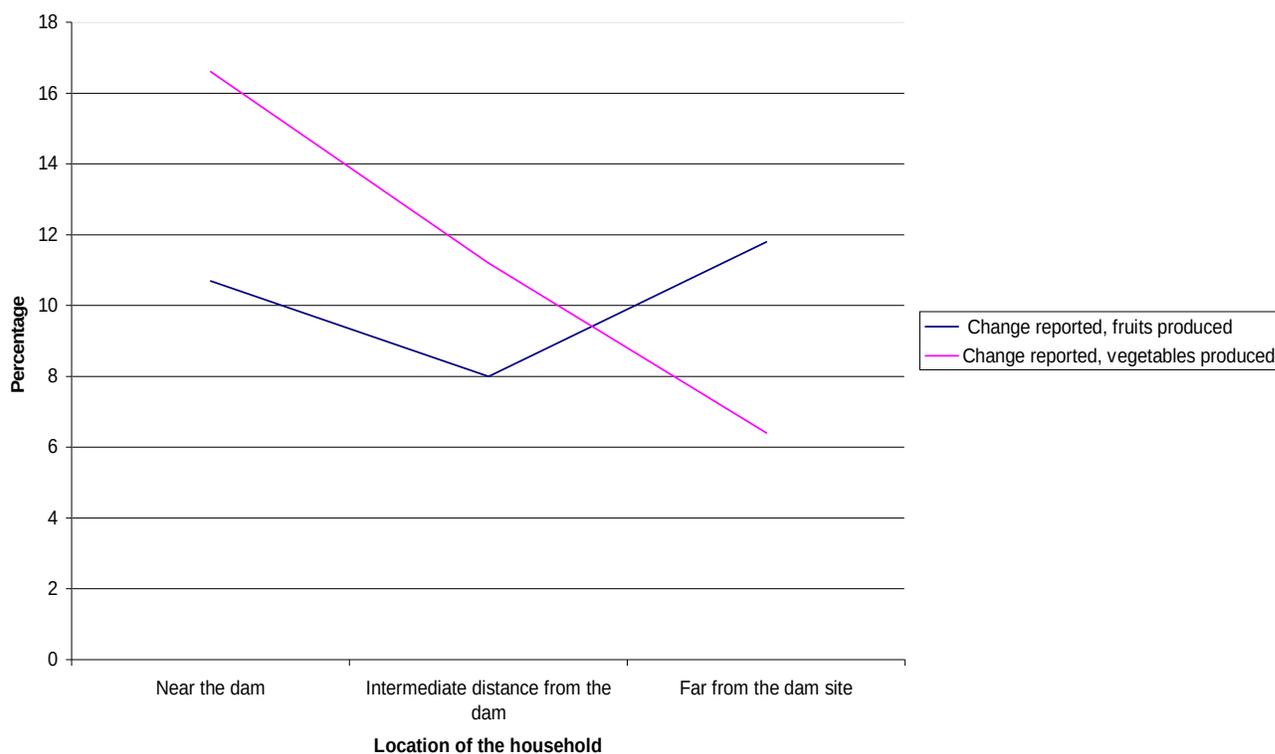
The location of the household within the village in relationship to a dam site does not influence consumption of fruits and vegetables. 67% of the households reported improved nutrition as a result of eating vegetables while 63% reported improved nutrition as result of consuming fruits. Households consuming fruits and vegetables are distributed almost equally within the village. See the graph below.

Unlike consumption, there is evidence of relationship between location of the household in relationship to the dam and vegetable production. 34% of the households in the study reported growing vegetables. Out of the total households growing vegetables, 17% are near the dam site, 11% intermediate from the dam site while the remaining 6 % are far from the dam site. The higher number of households near the dam site growing vegetables could be attributed to availability of water and the need to water vegetables every day. This gives the household near the site an advantage over the others

The production of fruits however followed a different trend, more households near and far from the dam site reported producing fruits while few households intermediate from the dam site reported producing. See the chart 1 below.

### **Chart 1: Household location and production of vegetables**

**% Distribution of households producing vegetables within the village in relationship to the dam site.**



## 2.3 Access to Staple Food Maize and Beans

### 2.3.1. Dietary patterns and nutritional adequacy

Food intake data was collected from 187 households with a total population of 636 adults and 732 children. During the study it was established that most families are extended in nature and both married and unmarried sons eat from the same pot with their parents. This explains the mean of 3.42 for adults among the study population.

A mixture of maize and green pigeon peas cooked together (isyo) was commonly reported for both lunch and supper. Green pigeon peas, which were in season during the study, took the place of the staple legume, beans. In most cases households prepared one meal, enough for both lunch and supper. 47% of the households reported having consumed fruits and vegetables the previous day. A considerable number of households reported consuming tea with milk for breakfast while meat was rarely consumed by the study households. A majority reported consuming meat once in a year over Christmas.

Foods prepared and consumed by the households is almost the same in both dry and wet season. One notable difference in dry and wet season is ratio of maize to beans. During the wet season the ratio of maize to beans is 2:1 while in the dry season the ratio changes to 2:0.25. The reduced ratio of legumes to maize, combined with poor consumption of dairy and meat products, reflect the low intake of protein among the study population. A few households reported having purchased a cow or goats after dam construction for money generated from business opportunities as result of the dam and were consuming milk. This is good indication of possibility of increased consumption of proteins if the scarce resource water is used economically.

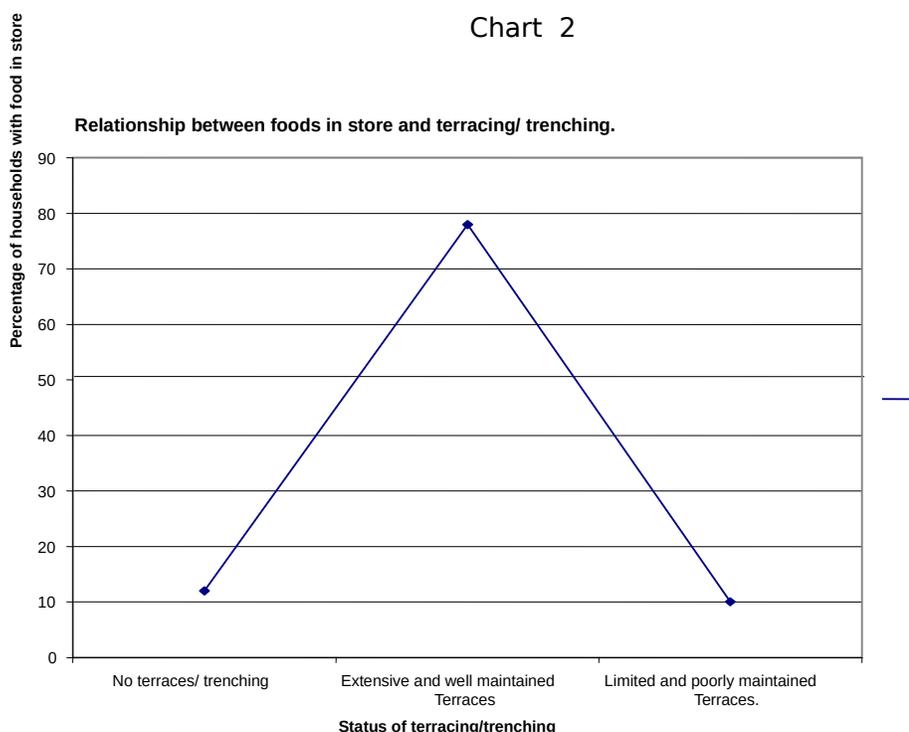
The dam has allowed production and consumption of vegetables during the dry season. Before the dam households only produced and consumed cowpea leaves during the rains. During the dry season, vegetables were absent from the diet as only households that were able to purchase vegetables from Kitui town or the local kiosks accessed them. After the dam, the dams have allowed an increase in water, especially among the communities served by dams with water for both household consumption and other uses, resulting in an increase in supply of vegetables. This has enabled the community both those that are growing and not growing to consume vegetables throughout the year. Cowpeas leaves are rain fed while kales, tomatoes are grown under irrigation during the dry season.

Children are fed from the adult's pot. When the common mixture of maize and beans is prepared, children's food is simply selected from the adult's pot. A few mothers however reported having prepared porridge for the children.

Food consumption is influenced by the food crops grown. There are two main rain seasons, the long rains November to January and the short rains April to May. Sustainability of the crops grown is influenced by the amount of rains received. Most often, the short rains are not reliable and farmers experience total crop failure especially for maize and beans, which are the main staple foods as indicated above. With experience farmers in Kitui district have learnt that pigeon peas, a perennial crop if planted during the long rains, are sustained by the short rains to maturity. This has made the crop more popular among the household and is produced both for household consumption and for sale. A majority of the households preferred eating pigeon peas green as opposed to eating when dry. There is a popular belief among the community in the four Ukambani districts that dry pigeon peas have no nutritional value. This is an issue needing to be discussed further with the community considering that pigeon peas will give yields with little rains.

The long rains are more reliable and 27% of the farmers reported having food in store. There is a strong relationship between terracing trenching and food in store. Of the households that reported having food in store, 78% have extensive and well maintained terraces/trenches, 10% have limited and poorly maintained terraces and the remaining 12% have no terraces. This shows clearly that terracing not only enhances maturity of the dam but also improves food production. Farmers who have terraced their land reported an increase in most of food crops grown while the majority of the farmers, including those with poorly maintained terraces, reported an increase in maize, beans and pigeon peas. Planting of grass on the terraces to maintain the terraces has improved pasture establishment, increasing fodder available for the animals. The presence of the dam is a potential for the community to appreciate the importance of water harvesting as an intervention to improved food security as result of increased production of the staple food, maize and beans, fodder for the animals and other food crops. This will allow a variety of food consumed by the communities improving their nutritional status.

Chart 2



The dams have no <sup>Maintaining</sup> reliance on stored food as food security coping strategy for harvesting but have also allowed increased business opportunities as result of an increase in water. Considering that there is limited increase in water and that rains received in Kitui districts are not enough to sustain rain fed agriculture, there is need to use scarce water to produce foods/business opportunities and livestock production that improve household's access to maize and beans. During the study it was clearly established that households better placed to buy staple food are those that had a business or selling bricks/vegetables and fruits produced through irrigation, selling other food crops produced, especially green grams and sorghum, and livestock to buy food. 62% of the household reported using combination of all possible coping strategy, as shown on the table below. The dam is thus an important asset if households will continue feeding their members during the drought which is common phenomena in Kitui. Table below shows the coping strategies used by the household.

**Table 8: Reliance on buying staple food as food security coping mechanism**

Coping strategy.	Frequen cy	Percent
Not buying food	8	4.3
Buying food with money from remittances	19	10.2
Buying food with money from sale of crops/ vegetables.	7	3.7
Buying food with money from sale of livestock	4	2.1
Buying food with money from business income,	20	10.7
Buying food with money from remittances and sale of crops /vegetables.	7	3.7
Combination of 1 to 4	116	62
Buying food but source of money used is not given.	6	3.2
Total	187	100

### 2.3.2. Water availability and increased business opportunities

In communities served by dams that have matured and have water available for both household consumption and other uses increased availability of water is generating some agriculture-related business opportunities. Young men are producing vegetables for sale locally and in surrounding markets. Road side kiosks are emerging as places where fruit and vegetables can be bought and sold locally. Some women have taken up the purchase of fruit and vegetables in area markets and then re-selling these food items locally. Similarly, local fruits and vegetables are being purchase by women and then re-sold in the larger area markets. Bricking-making for sale was also made possible by increased water supply in some villages.

To establish whether an increase in business opportunities is as a result of the dam, a correlation between water condition and increase in business opportunity was done. Results established that of the 54% of households that reported an increase in business opportunities, 33% are served by mature dams with water for both household consumption and other uses. Dams with water for livestock reported the least number of cases, 1%. Business opportunities as result of the dam include expanded crop production, vegetable growing, livestock production, brick making, and basket and rope weaving. Income generated from the expanded business opportunities is used to buy staple food, maize and beans, clothes, pay medical and education expenses. It is important to note that households with expanded business opportunities were able to buy staple food. Time saved from collecting water allowed women to get involve basket and rope making. Money earned was used to buy food (see the chart below).

**Table 9: Average income of the study population**

	Mean	Frequency	Std. Deviation
No evidence reported	1,699	87	4,706
Increased crop production	3,778	16	5,051
Vegetable production	8,233	36	16,536
Livestock production	4,750	2	6,718
Combination of the above	9,357	21	11,562
Brick making	1,600	6	1,679
Other form of business - basket and rope weaving, food kiosks, retail shops	700	19	2,646
TOTAL	3,923	187	9,466

The mean income for all the study household is ksh 3,923, the highest mean recorded is from households growing vegetables

### 2.3.3. Role of soil and water conservation in achieving food security

As indicated above the households best able to access staple food are those that have put sound water and soil harvesting techniques in place. 82% of households that reported using a combination of resource inter-relatedness in soil conservation practices, tree/grass planting and composting had food in store. 62% of the households that had put in place water harvesting techniques had food in store, while 32% that practiced inter-relatedness in farming practices had food in store. The high percent of household practicing interrelatedness and had food in store explains the importance of soil and water conservation in achieving food security (see Table 10).

**Table 10: Evidence of resource inter-relatedness, soil conservation practices: correlation between inter-relatedness and reliance on food in store**

Soil conservation practice used at the household	frequency	Percent of total	Food
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No evidence of relatedness	16	8.6	2	4
Evidence-grass & tree plant	22	11.8	3	6
Evidence in compositing	20	10.7	4	8
Combination of the above	129	69	41	82
Other practices	0	0	0	0
Total	187	100	50	100

**Table 11: Evidence of inter-relatedness in water harvesting technology**

Water harvesting technology used at the household level	frequency	Percent of the total study population using the technology	Food	
			Number of households using the technology and have food in store	Percent of households using the technology and have food in store
No evidence	33	17.6	7	14
Terracing or trenching	124	66.3	31	62
Water collection in cistern	3	1.6	0	0
Terracing/ collecting water in cistern and trenching	25	13.4	12	24
Other practices.	2	1.1	0	0
Total	187	100	50	100

**Table 12: Resource inter-relatedness in improved farming practices and technologies**

Improved farming practices used at the household level	frequency	Percent of the total study population using the practice	Food	
			Number of households using the practice and have food in store	Percent of households using the practice and have food in store
No evidence	63	33.7	11	22
Inter-relatedness in crop production	44	23.5	16	32
Inter-relatedness in vegetable growing	38	20.3	9	18
Inter-relatedness in livestock production	4	2.1	0	0
Combination of the above	37	19.8	14	28
Others	1	0.5	0	0
Total	187	100	50	100

*2.3.4. Impact of increased access to water on the well-being of women*

Prior to dam construction, women in the study population had to get up at the crack of dawn and walk long distances up to ten kilometers down uneven paths covered by thick bushes to collect water for their households use. The situation is even worse during the dry season as women walk twice the distance. The main sources of water are scooped holes made (dug) on dry river sand beds. The scooped holes get deeper and deeper as the dry season progresses, and at times can get very difficult to reach with steep sides which sometimes collapse killing women. In one village, the interviewee reported having lost more than ten goats that rushed to take from the hole. Despite having to walk long distances, the interviewee reported that often women have to wait in turns to collect water. Waiting adds to the time taken to walk to the water source. It is also reported that some of the sources almost dry out and it takes long for one woman to fill the twenty litre container mostly used to collect water.

The study established that on average women spent 2.2 hours a day and collected and average 88 litres of water per day. Upon returning from the journey, they started their day's work of cooking, washing, taking care of the children, livestock and farm activities. Time taken collecting water denied the family both breakfast and lunch as the mothers spent the morning collecting water. At times, children left for school without taking a bath and without breakfast. The interviewee also reported that after the long journey and heavy load, they were too tired to get engaged in any productive activity.

The dam has allowed increase in water and reduced time taken to collect water. On average the study population takes 1.3 hours and collects water on average 98 litres of water per day. Increase in water has impacted positively on the community and there was evidence of change in health status as a result of the following:

- more water to cook and clean;
- quality and better water from the source; and
- boiling drinking water or using water guard.

The study revealed that there were changes in health status as a result of the dam. This was established by relating health status of the study population to the condition of water in the dam (see table 13).

Increased involvement of women and children to fetch water was reported in 6% and 23% of the households respectively. Before the dam, children involvement was reduced by the fear of crossing the road for some households and the risk of traveling long distances to collect water especially for the girl child, while men were more involved in watering the animals.

Increased involvement of women and men has relieved women of the responsibility of collecting water freeing time for other activities. In some households, the responsibility of collecting water is entirely the children's responsibility and water is collected after school.

Time saved from collecting water has impacted differently on the households. There is evidence of more timely meal preparation and greater variety of food prepared at the household. This was reported by 48% and 66% of the households respectively. 55% reported investing more labour in farm work both crop and livestock production while 22% reported greater involvement in group activities. Evidence of women's involvement in new businesses was reported by 27% of the households.

**Table 13: Health status of the study population**

Status/	Change in health status because of more and/or cleaner water	Total

condition of water in sand dam	No change worse	Improved health, more water to cook and clean	Improved health, quality better water from source	Combination of 1&2	Improved health boiling water and/or using water guard	Combination of 1&4	
No water in sand dam at present	23	8		1	21	11	64
Water available for household consumption		1			1	6	8
Water available for household consumption And other uses	7	21	2	13	7	41	91
Water too contaminated for household use		1		1	1	2	5
Water too salty for human consumption	6	1			6	6	19
Total	36	32	2	15	36	66	187

There was also evidence of women involvement in decision making on how household income is spent. 26% made independent decision while 40% made decision jointly with the husbands.

#### 2.3.5. Impact of increased access to water on the well-being of children

Among the communities in the study area, the responsibility for collecting water is for the boy child and girl child, mother and, occasionally, adult men are involved. This was evident during the study. 23% of the households in all dams reported increased involvement of children while 6% of the household reported increased involvement of men.

Out of the total households reporting increased involvement of children, 61% are within the dams with water available for both household consumption and other uses, 23% are within dams without water, 9% are within dams with water available for household consumption only and the remaining 3% within dams with water too salty for human consumption.

55% of the households reporting increased involvement of men are within dams with water available for both household consumption and other uses, 27% are within dams with water but too salty for human consumption and the remaining 9% are from dams without and dams with water but too contaminated for household use respectively. 72% of the household did not report any change. Out of this total, majority 40% are within dams without water, 44% are within dams with water for both household consumption and other uses, 10% are within dams with water too salty for human consumption and remaining 3% are within dams with water too contaminated for household consumption (see Table 14).

Table 14: Involvement of children and Men in collecting water (per cent)

	No change	Increased involvement for men	Increased involvement for children
No water in the sand dam	39.8	9.1	23.3
Water for household consumption	3.0	0	9.3
Water for household consumption and other uses	44.4	54.5	60.5
Water too contaminated for house hold consumption	3	9.1	0
Water too salty for household consumption	9.8	27.3	7.0

The study established that increased involvement of children in collecting water is as a result of the dam; before the dam water was collected at night or at the crack of dawn, the paths to the river are uneven and covered with thick bushes. The state of the paths and the time of night when water was collected posed danger to the children. As a result, it was risky for children, especially the girl child, to collect water. Boys were more involved in watering animals. Interviewees reported boy children would accompany male adults on the weekends, at day time, to water animals.

Dams constructed have allowed more water near, the path to the river and distance is safe, and in some villages children no longer have to cross the road to go and collect water. Hence, an increase in the involvement of children.

#### 2.3.6. Effects on education

Interviewees reported that although there was little involvement of children collecting water before dam construction, collecting water is both physically stressful and time consuming. Before the dam, both the girl and boy child walked same distances when they accompanied adults to collect water. The long distance walked plus coping with the weight of the water container on small children was very stressful (as stated earlier water especially during the dry period was collected at night). One of the most serious effects is that children involved in collecting water at night slept tired and for very few hours. As a result they did not concentrate and their school performance was poor. One mother from dam 630 kwambika had this to say,

*“before the dam my son left the house at 10.00pm and got back home at between 12.00 midnight and 1.00pm, sleep at 2.00pm and wakeup to go to school by 6.00am after only 5 hours of sleep then walk 4 kilometers to school. Upon arrival, the children were too tired to concentrate and recorded poor performance. As a result my children repeated every class and they did not go beyond primary education”.*

*Today the dam has allowed water is near home and children collect water after school; wash uniforms, take a bath and then take time to study or do home work. With water collected supper is ready by 8.00pm. By 9.30pm they take supper and sleep, they wake up at 6.00am after 9 hours of sleep take breakfast and walk to school. They now concentrate better and their performance has improved. They do not repeat class and I believe my last born son and my grand child will join secondary school”.*

Cases of children going to school without breakfast were reported. Women who left for the river at the crack of dawn got back home between 8am and 9am and found their children

had left for school. In most cases these children slept without having eaten enough. As a result, the energy levels went down during the first half of the morning. These children lost concentration and performed poorly.

In periods of droughts as evident during the study, schools from Kitui benefited from school lunch programme. Children were required to carry water for cooking, washing and drinking from home, in case when there was no water at the household in the morning children didn't attend for fear of being punished.

Other than the dams constructed some primary schools have benefited from Tanks constructed with assistance from SASOL and other organizations. For schools without tanks, children are able to collect water in the evening after school. Children do not miss school anymore unless when sick.

Before the dam it was reported that household members both adult and children took a bath once in two days and with very little water. Lack of enough water for bath prevented girls from attending school, particularly when they are menstruating. During the study interviewee mothers reported that the girls were sick and did not exactly want to explain they just said "there times when a girl cannot go to school without taking a bath".

Constructions of the dams have allowed more water; as a result, there is evidence of changes in education opportunity as a result of the dam.

A majority of the households reporting changes in education opportunities are within the dam with water for household consumption and other uses. 10% increased enrolment and improved study, 9% had more time, and 2% are performing better in school due to improved nutrition and cleanliness. 6% reported a combination of opportunities. Out of the total number, 17% reported increased enrolment and or improved study. 47% are from within dams with water for both household consumption and other uses.

### 2.3.7. Health

Children are most vulnerable to the diseases that result from lack of water or using dirty contaminated water particularly diarrhea. To determine the prevalence of water related diseases interviewee were asked to recall disease most common among the children in the household. 8% of the total population reported no change in incidences of the diarrhea, 8% reported reduced incidences, 6% reported increased incidences and the remaining (majority) 79% of household did not mention diarrhea (an indication of low incidences of diarrhea both before and after the dam).

**Table 15: Reported incidences of diarrhea (interviewee capacity to recall)**

Evidence of reduced incident of diarrhea	frequency	Percent
No change reported	14	7.5
Reduced incidence since dam construction	14	7.5
Increased incident since dam construction	11	5.9
Not mentioned	148	79.1
Total	187	100

### 2.3.8. Disease incidences

Generally there were few incidences of water related disease affecting children in the study household. Disease mentioned includes, diarrhea, malaria, URTI, typhoid, amoeba and shistosomiasis. There are more incidences of Amoeba Malaria and URTI reported while shistosomiasis was the least mentioned.

For all the disease mentioned there were cases of increased incidences and reduced incidences after the dam construction. The chart below compares the number of the reported cases of increased and reduced incidences of diseases mentioned. Table 16 shows that there are more cases of increased incidences of malaria URTI, Typhoid and Amoeba after dam construction, while Diarrhea and Shistosomiasis reported more case of reduced incidences.

**Table 16: Percentage of reported incidences of water related diseases**

Incidence	Diarrhea	Malaria	URTI	Typhoid	Amoeba	Shistosomiasis
Reduced incidences since dam construction	7.5%	6.4%	2.7%	2.1%	5.9%	3.2%
Increased incidences since dam construction	5.9%	10.7%	10.7%	7.5%	12.8%	0.5%

Reduced incidences of diarrhea could be attributed to increase in water to cook and clean. Interviewees reported that the dam has allowed more water and as a result, children are clean, they bath once per day, wash clothes and drink boiled water or water treated with water guard. There was evidence of leaky trims (tins with water with a hole hanged outside the latrine used for washing hands after visiting the latrine), an indication that the practice of washing hands after using latrine is still practiced. The percentage practices of household washing hands after using the latrine was not established during the study except for the observations made. It may be important to establish the hygiene practices in future. This will help explain the reasons for the reported reduced incidences of diarrhea. The high percentage of household with pit latrines as a result of training provided by the SASOL has impacted positively - reducing the incidences of diarrhea. This has also reduced human waste in the water source hence the low cases of shistosomiasis; only household collecting water from Kalundu River reported cases of latter disease. Reported cases from this river could be attributed to the fact that the Kitui town raw sewage is emptied into this river.

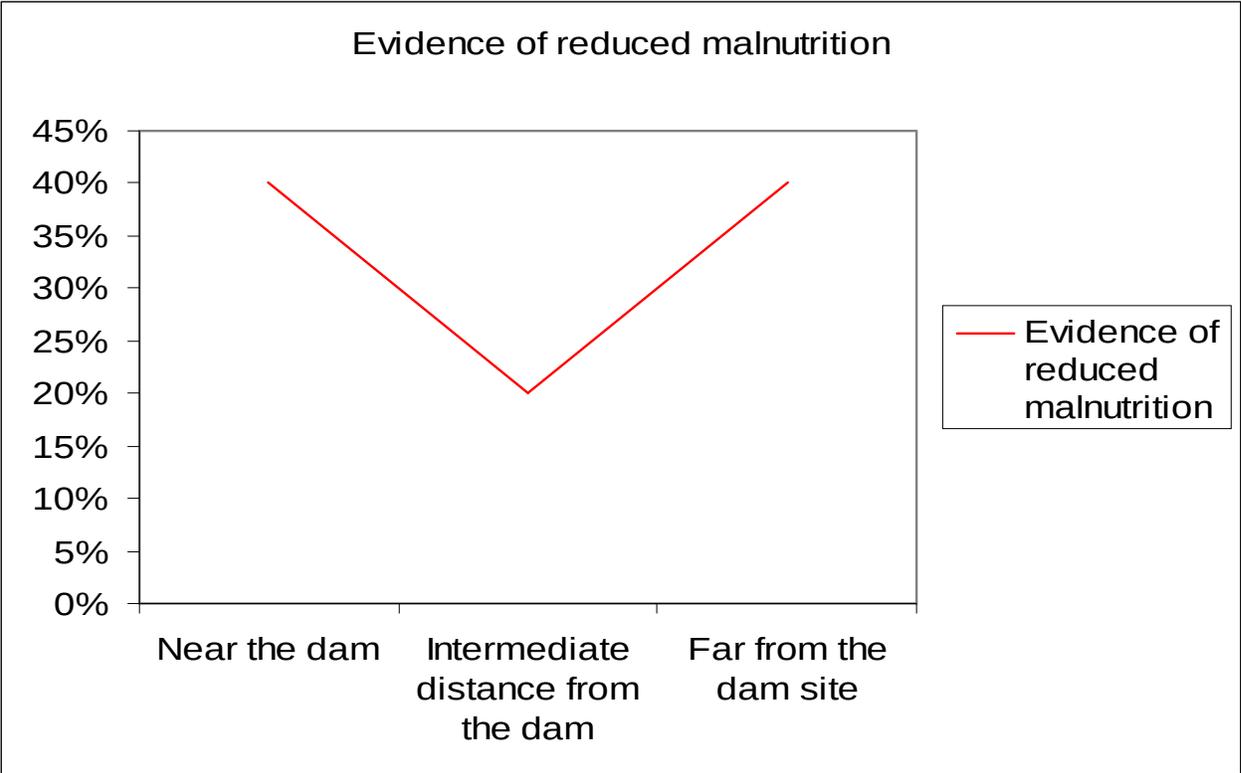
*2.3.9. Limited evidence of malnutrition*

Information collected during the study indicates a limited evidence of malnutrition among the study households. To establish whether there incidences of malnutrition the interviewee, the lead female of the household, was asked to recall the most common diseases affecting children less than five years and school children of the household both before and after dam construction. Among the diseases recalled, there were no cases of increasing incidences of malnutrition reported by the study households. Evidence of reduced malnutrition was however reported by 5% of the households. Malnutrition (kwashiorkor and marasmus) was recalled in the form of symptoms of the two mentioned forms of malnutrition and advice given at the health centre. Of the reduced cases reported, 90% were reported by households served by dams with water for household consumptions and other uses. It was also interesting to note that majority of these household are either far or near the dam site. Household intermediate from the dam site reported less cases of

reduced malnutrition. This follows the same trend with households that reported improved nutrition as result of eating fruits and vegetables. Majority of the households reporting improved nutrition are far and near the dam site while less household intermediate from dam site reported consuming fruits and vegetables as shown below.

Reduced incidence of malnutrition, as it relates to sand dams is a more complex issue and is as a result of many woven factors which may not be adequately addressed by this study. It is important to note that no anthropometric data was collected and evidence of reduced malnutrition is based on what the interviewee was able to remember. Information collected indicates improved food consumption as a result of the dam. The dams have allowed an increase in water leading to increased

**Chart 3: Evidence of reduced malnutrition in relationship to location of the household within the village**

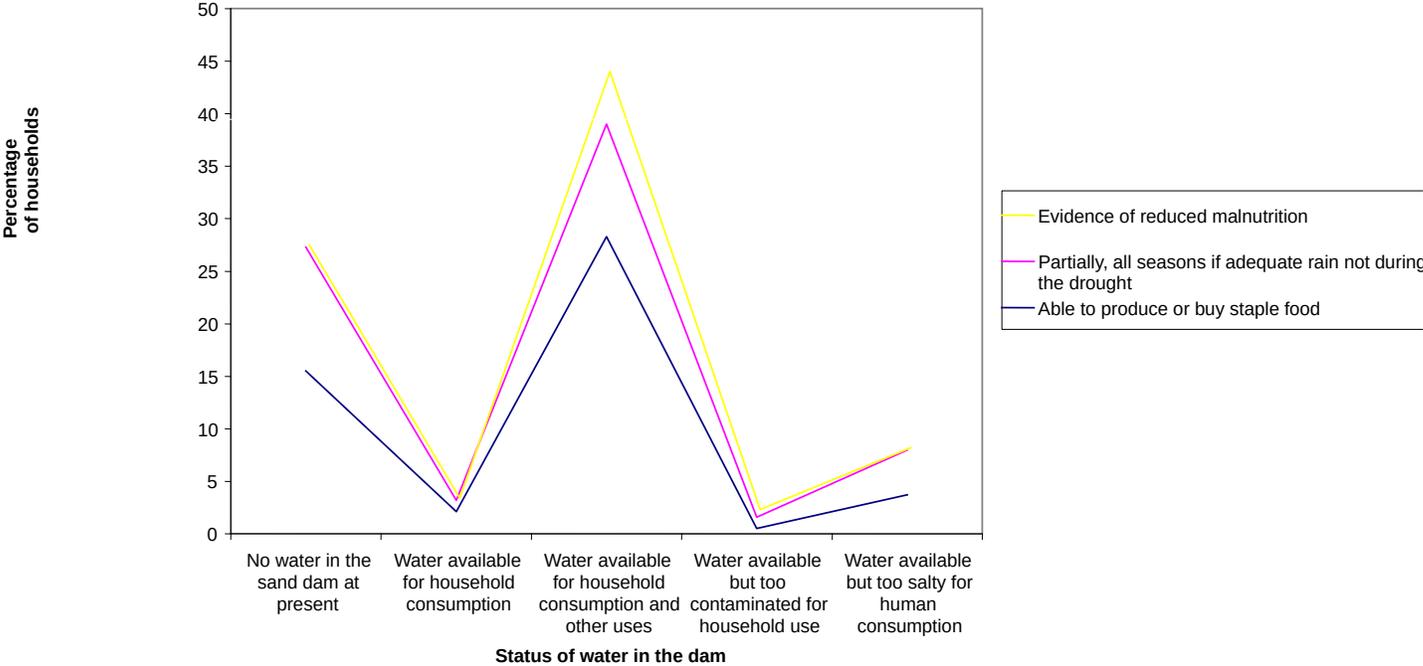


production and consumption of fruits and vegetables. There was evidence of greater food security as a result of the dam. There was more evidence among the household within dams with water for both household consumption and other uses than household within the other dams (see chart 4).

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Chart 4:

Impact of greater food security as result of the dam on malnutrition.



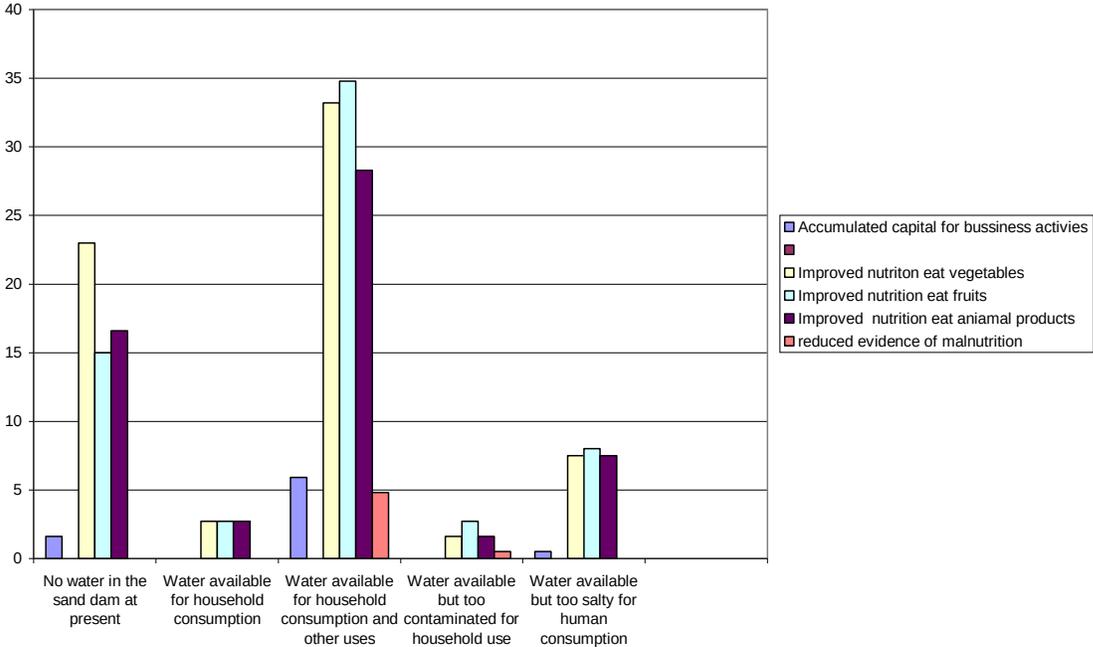
This is further confirmed by comparing consumption of fruits vegetables, animal products and ability of the household to eat more regularly. Information collected show that all these

variables follow the same trend. Household within dams with water for both household consumption and other uses reported higher case of consumption of these food types influencing the trend of reduced incidences of malnutrition within the households which is further influenced by the status of the water in the dam (see the chart 5).

Household that reported having received training from SASOL on terracing /trenching and water quality nutrition and health reported increased crop production as a result of terracing /trenching leading to reduced incidences of malnutrition. This gives an indication that combination of more water and better water harvesting techniques coped with training on health and nutrition would have greater impact on nutrition security.

There were reduced incidences of water related diseases reported among the study households, as explained earlier, more water to cook and clean and boiling drinking water or treating water within water guard has resulted to reduced incidences of water related diseases. Reduced incidences of diseases improve food absorption leading to better nutrient intake and utilization resulting to better nutritional status.

**Chart 5: Impact of consumption of variety of foods on malnutrition**

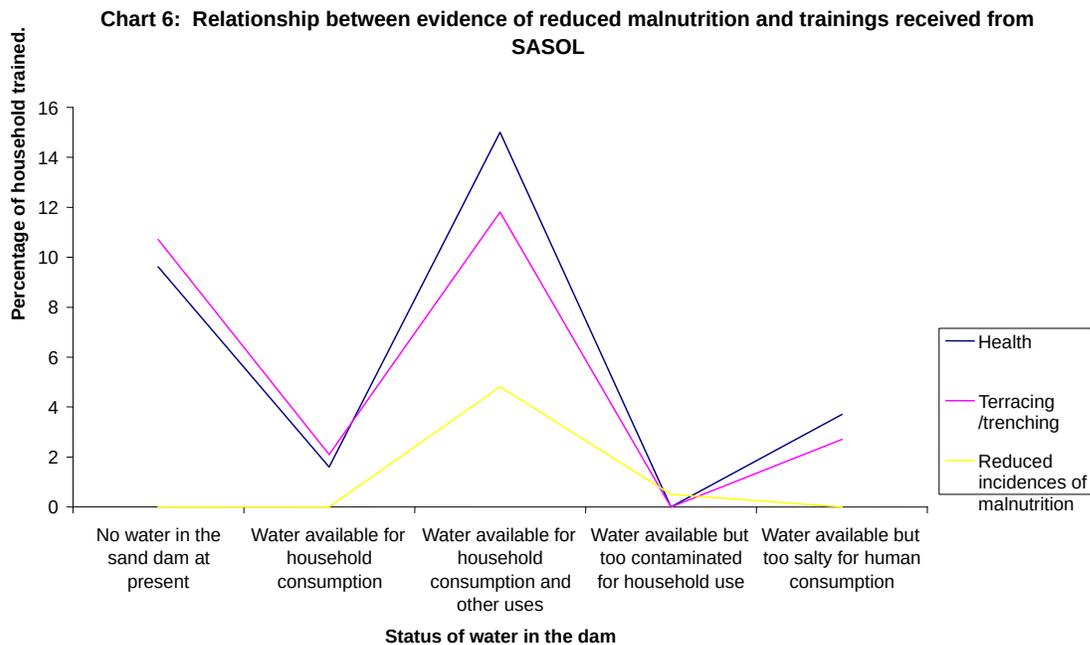


### 3.0 Health Status of the Community

#### 3.1. Addressing Water-related Diseases

To determine incidences of water-related diseases the interviewee was asked to recall most common diseases affecting children both before and after the dam construction. As discussed on section under impact of water on children’s health, there are few incidences of water related diseases affecting the sand dam community. Increased incidence of malaria, URTI and amoeba were reported while reduced incidences of diarrhea and shistosomiasis were reported. Information collected during the study give an indication that diseases related to water can be prevented.

Prevention of water related diseases can be achieved through promotion of improved hygiene and sanitation by all members of the community (men, women and children). To achieve this, training that facilitates sustainable hygiene and sanitation behavior change and practice is a must. In attempt to ensure that the sand dam communities receive messages that impact on adequate hygiene and sanitation practices, SASOL takes the community through PHAST (participatory hygiene and sanitation transformation training). The approach is based on need for



community participation in investigating the local environmental situation, visualize a future scenario, and analyze constraints, then plan for change and implement an accepted program of action. A few members of the sand dam community were trained as ToTs and provided with training tool kit. The ToTs trained were charged with the responsibility of training the rest of the sand dam community. As stated in other sections of this report, message carried to the larger community depended largely on the topic of interest of the trained Tot. Interviews with the committee confirmed that most of sand dam community members received training on sanitation and hygiene. This may properly explain the low incidences of water related diseases.

During the study, the team established that the training on sanitation and hygiene has had a positive impact on the community. Construction of pit latrine is one of the messages that was well received and implemented. 87% of the households have pit latrine and only 13% are without. 7% of these household are near the dam site, 3% are intermediate and the remaining 3% are far from the dam site. Those without latrine reported using neighbours' pit latrines, which has reduced contamination of the sand dam with human waste. There was evidence of washing hands after visiting latrines; in a few homes, leaky tins were present. Presence of dish racks was also evident. These practices combined together impact positively on water related diseases.

Increase in water has resulted in change in health status because of more and, or cleaner water. This was reported by 82% of the study household, 49% of these household are within dams with water for household consumption and other uses, 4% are within dams with water for household consumption, 3% within dams with water too contaminated for household use, 10% within dams with water too salty for human consumption while the remaining 34% are within dams without water.

### **3.2. Knowledge and Practice**

Cases of community members receiving messages and not acting on the message received were evident. To establish this interviewee was asked to express concern about dam contamination. 12% expressed no concern. 9% of these household had receive training from SASOL and other organizations. 23% expressed concern but takes no action. Out of this percentage, 16% have received training on health, nutrition and water quality. The bigger percentage, 65%, expressed concern and took action. 66.7% of these household had received training. Information indicates a small number of households not taking action. The study also established that SASOLS contact with the community is only during dam construction. This may explain the knowledge and practice gap. Follow-up to reinforce the message received may increase the number of households taking action resulting into reduced incidences of water elated diseases.

### **3.3. Maintaining a Supply of Water for Human Consumption**

The use of chemical pesticides and fertilizer for vegetable production in stream beds or in the proximity of a sand dam may have long-term harmful affects. 34%of the study households reported increased output of vegetables as a result of the project. 17% of these households are near the dam, 11% intermediate and the remaining 7% are far from the dam site. Observations made during onsite visits made it clear that vegetables are grown next to the river for ease of watering. The closeness of vegetables to rivers poses the danger of contaminating the water with chemicals and fertilizers used on the vegetables. The bucket method for irrigation makes the situation worse as the same containers used for mixing chemicals are used to draw and cleaned at the scoop holes. There is also the danger of consuming the vegetables that have chemical residue. The recommended waiting period after spraying ranges between 7 to 14 days. The need for money coped with the source vegetables may drive the youth to sell the vegetables before recommended waiting time.

Effects of long-term use of chlorine to purify drinking water are unknown and need to be monitored. 19% of the households reported they were either boiling drinking water or treating with guard. On wanting to establish the source of information especially on the use of water guard, media mainly the radio, chiefs meeting, the health centers and friends/neighbors were some of the sources reported. The interviewees admitted that information received was incomplete in that instruction for use was not given but they were supposed to read on the instruction on the label. The waiting period after treatment was not clearly understood: some interviewees said the waiting period was one day, a day is not specific waiting period should be given in hours. Consuming water before the waiting period cannot be ruled out especially for children even when waiting period is known. Child

care practices facilitating continuous monitoring of children and ensure that they do not take water before the waiting period may not be adequate.

Attempts to clean a well by pouring in chlorine can be dangerous. One sand dam community, Ndivuni, reported cleaning the shallow well by pouring in chlorine. The amounts poured waiting period and amount of water recharge is not known, this could be dangerous to the community.

It is important to note that the sand dam community is at danger due to use of chemicals for spraying vegetables and chlorine used to purify water both at home and at the well. The health effects of long term use of chlorine and chemical deposits on water and food need to be monitored further and sand dam community trained on use of chemicals and chlorine.

#### **4.0 Gender Issues**

The structure of implementation of the sand dam project flows from SASOL to the community through the local administration. The main agenda of the information is construction of sand dam as a means of increasing access to water. The message is better received by women and is the majority during the meeting. Discussions during this important meeting revolve around the construction of the sand dam where construction means contributing money, food and labour in terms of time by the willing members of the community. To initiate participation community mobilization is a must.

Given the need to mobilize the community a man was seen as more appropriate for the position of chair of the dam construction committee. Similarly, given the need for trust in the collecting, holding and spending money, a woman was preferred for the position of treasurer. The inclusion of both men and women on the committee created a democratic platform for decision-making and the active participation of women. Where women as well as men had a voice in this democratic process opportunity was provided for all to participate in the construction of the sand dam, which, in turn, increased the community's sense of ownership of this major investment. This was confirmed by the information collected. Out the 30 dams visited, 33% of the committee had a woman as the treasurer, 7% had a woman as the chair, 13% had a woman as the village elder, 23% had women in different positions for instance chair, secretary and treasure while the remaining 23% did not report active involvement of women.

#### **5.0 Migration Effects of New Economic Opportunities**

Rain fed agriculture in Kitui district is dependent on two rain seasons. The long rains, October to January and the short rains, March to April. The study established that the short rains are usually inadequate and do not support rain fed agriculture. Complete crop failure for crops in season during study was reported as families have a food deficiency and 73% of the study households did not have food in store and only 27% reported having food in store. The situation is usually made worse by prolonged drought running from June to October/November when the next rains are expected.

To meet the food deficit, study households reported buying food with money from sale of charcoal, sale of livestock both big and small, casual labour and remittances from children and friends. Famine relief in form of food for work was provided by both the government and the development organization in the area. ADRA and World Food Programme were evident in the area.

In times of prolonged drought food prices continue to increase as the drought advances straining the households' meager resources. For the households dependent on livestock as

a coping strategy the livestock prices decreases as the prices of staple food and beans increases

During the study, the price of he-goats had decreased from 1,500 in January to 500 in July, while the price of 1 kg of maize had increased from 12.00 in January to 22.00 in July. As a result, money from sale of livestock command very little amounts of maize and beans.

In this adverse situation, household members eat less frequently and eat less during meal times and at times go without food in a day or go without food. In times of food scarcity, women and children are most affected. To increase the household food basket, young men and girls usually migrate to town in search of employment. Interviewees reported that in times of drought labour demand within the community is very low since the drought does not allow engagement in any productive activities. As a result there is very little family labour to employ.

Where agriculture-related business opportunities were being pursued there was evidence of a reduced need for out-migration, especially by young men, to seek employment. Increase in water has allowed an increase in economic opportunities/farm activities to employ family labour, reducing out-migration.

## 6.0 Capacity Building

### 6.1. The Effectiveness of SASOL’s Training

The success of any community based project depends largely on the capacity of the community to conceptualize and participate in the entire project management cycle from needs identification phase to project implementation phase. The facilitating organization should therefore ensure that the capacity building of the participating community is properly build to ensure adequate participation. SASOL Foundation in its efforts to support communities access water, has provided training prior to dam construction and during dam construction. The two main modules include natural resources management and sanitation and hygiene.

Where training had been provided by SASOL, there was some evidence that the members of the community did not understand adequately the training received. Some examples of failure to act on the training message provided were in the areas of animals contaminating the sand dams, soil conservation, terracing, and the planting of trees and grass. The importance of constructing pit latrines was received more readily. Possibly this indicates a better understanding of the need, and hence more receptive to the message, and/or the message was re-enforced by other sources, e.g., health professionals.

### 6.2. Sand Dam Contamination

Of the 30 dams studied, 60% were contaminated. The main physical evidence of contamination was donkey dung and few cases of cow dung. There were two cases where human feces were physically evident.

**Table 17: Physical evidence observed of sand dam contamination**

	Frequency	Percent
No evidence	12	40.0
Evidence of contamination	18	60.0
Total	30	100.0

### **6.3. Value of Soil and Water Conservation Practices**

The study also established that despite the training, there were cases of households that did not act on the message passed on the value of terracing and trenching. 18% have not terraced their land and 20% have not planted grass and or trees on their *shamba*. As reported earlier, construction of pit latrine was the best received and implemented message comparatively. 87% of study household had evident pit latrine and only 13% did not have. Some of the household without reported they were using the neighbour's latrine.

Training messages were received from different organizations and there was evidence of reinforcement of messages by organizations carrying out similar activities or training in collaboration with SASOL. Kitui Development Centre, formerly World Neighbours, is a key collaborator and both natural resources management and the sanitation and hygiene training are facilitated by both organizations. Collaboration with the Ministry of Health was also evident during the sanitation and hygiene training. This may explain the high construction of pit latrine. Other organizations involved in passing messages include Ministry of Agriculture, Educational institutions, Kitui Agricultural Project, JICA, ADRA, AMREF, CCF and the Anglican Church of Kenya. Some interviewees also reported having received information, especially on use of water guard, through the radio.

### **6.4. Training of Trainers as a Capacity Building Strategy**

Training a few identified/selected community member (ToTs) to train others is considered by most organizations as more efficient, affordable and sustainable strategy. However caution should be taken to ensure that persons selected for the training will effectively understand course content during the training and be able to pass the same to the community that they represent. The duration of time taken should also be enough to cover the intended content without straining the participants among others. At the end of the training, the participants together with the facilitators need to draw a follow-up plan to enable follow up ToTs, identify facilitation gaps and back them up to ensure messages passed to the community are accurate and complete.

During the study, there was some evidence that persons trained were not transmitting effectively the message received. This is a product of a limited ability to transmit the message or an inability to mobilize community action to implement the content of the training message. It may also indicate the training of trainers was too intensive to be absorbed effectively. Three villages claimed they had not received any training from SASOL, which is an indicator of the lack of effectiveness of some trainers who had received SASOL training.

An evaluation of the natural resources management training confirmed this. After the morning session, participants were asked what messages they were going pass to their communities when they got home. All of them reported that construction of pit latrine was a must. The team established that message passed by the ToTs was dependent on what the particular person found interesting or important. The rest of the information never gets to the community and if it does they just mention.

On-site visits and interviews with the sand dam construction committees and communities also revealed that some of the ToTs do not pass any of the messages received during the training. Reasons given to this was that constructing sand dam is hard work and usually the community is too tired to learn after a days work. Also, some of the ToTs are illiterate and cannot read or write; messages passed depend on their ability to remember. Another reason given was that some of ToTs are not active and seldom reach the community. In one of the dam sites, a mother expressed concern that her son was trained to train another community which he did while the person who was supposed to train her particular sand dam community did not organize any training. As result training received by ToTs was not

passed on to this community. Considering the above there is need to re-think the strategy, identify the gaps and plan to address the identified gaps.

### **6.5. Capacity Building to Create an Understanding of What Is a Sand Dam**

As explained earlier, the sand dam paradigm is built on water as an entry point to community development and appreciates water as a main input for many productive activities. For communities to get involved in planned productive activities, the dam constructed must then mature into a sand dam to allow increase in water. The principle behind the paradigm is that the dam will fill up with sand creating a sand bed. It is this sand bed that is used to store water from the rainy season for use during both dry and wet season. A dam that has filled up with sand as desired is referred to as a mature sand dam. Realization of sand dam benefits therefore depends on a dam maturing into a sand dam. Constructing a dam and facilitating its maturity into a sand dam is an important process that needs to be understood by both SASOL and the community and appropriate capacity building modules developed and implemented to ensure that complimentary activities that enhance maturity of the dam are not only understood but implemented.

The study revealed that, in some cases, the sand dam community involved did not understand what constitutes a sand dam. They were under the impression they were constructing a traditional dam designed to hold surface water. As a result, they were unaware that the realization of dam benefits was dependent on a dam maturing to a sand dam. The capacity building extended by SASOL prior to and during dam construction was inadequate to emphasize the need for community action to prevent silting, to maintain the dam, and to repair both the dam structure and the means of preventing the silting of the dam. as explained by the tables below.

### **6.6. Transfer of Water Harvesting Technology at the Household Level**

To establish whether the sand dam community understands what constitutes a sand dam, the interviewee was asked to mention sources of water contamination and action taken by the household to ensure that water stored in the sand is not contaminated. From the responses it was evident that there were cases where the sand dam community did not understand what constitutes a sand dam. It was noted with concern that there were few cases where terracing, animal waste, washing and bathing at the river, pesticide used on vegetables and watering animals at the river were all recalled and related by the same household. A majority only recalled one or two causes while others said that water stored in the sand cannot be contaminated as result no action needs to be taken to ensure that water stored in the sand is not contaminated. Lack of pit latrines was the most frequently reported cause of contamination and was the most controlled contamination. A majority of the households reported that they had constructed a pit latrine as an action to ensure that water is not contaminated and only a few reported having terraced their land, watered their livestock at home, and did not bath at the river.

A further in-depth discussion revealed that to some sand dam community members, water in the sand dam was to be stored on the surface and, according to them, absence of water on the surface was a failure on part of the dam. In two dams the community had not attempted to scoop any hole since dam construction. On wanting to establish why the community had not attempted dig scoop holes, the committee and some community members present during the interview reported that SASOL had told them that they are to wait for 5 years before a dam matured. A few isolated cases of interviewees who strongly felt that construction of the sand dams has reduced the amount of water available during the dry season were also recorded. To further establish sand dam community understanding of sand dam paradigm as a water harvesting technology, household perception was sought (see table 18).

Table 18: Evidence of transfer of water harvesting technology-household's perception

	Frequency	Percent
Failure	9	4.8
Successful transfer	122	65.2
Partial transfer, do not understand sand dam	25	13.4
Partial transfer, failure to maintain sand dam	13	7.0
Partial, does not address clean water for human consumption	10	5.3
Partial transfer, community conflict	8	4.3
Total	187	100.0

Successful transfer of understanding sand dam paradigm as a water harvesting technology was evident among 65% of the sand dam community, 13% have partial transfer as they do not understand sand dam, 7% failed to maintain sand dam, 5% does not address clean water for human consumption, 4% had partial transfer evidence of community conflict while the remaining 5% failed to understand water harvesting technology completely.

#### **6.7. Capacity of the Community to Maintain the Sand Dam**

67% of the sand dam community is served by dams that are functioning well, 14% by dams that are leaking, 13% by dams that are maturing and the remaining 4% by a dam that has failed completely. During the study it was established that sand dam community was aware of the dam condition and did not take action on the dams needing action. Repair of dams that were leaking was an issue of concern. The committee reported that they did not have the required skills and as result were not able to repair the leak. In one dam, the community had attempted to repair but the dam was still leaking. Considering the age of the sand dam, it was noted that dams that are leaking were constructed between 2002 and 1998 and are between 3 and 8 years old while the dam that has failed completely is 7 years old. Despite the failure, the participating sand dam community did not take any action to establish reasons for the failure and address them.

The study established that this particular dam did not have its banks protected a reason that the community with adequate capacity building should have identified and addressed. *The table 19 shows the age of the dam and its status.*

Table 19:

Age of the dam \* status/condition of the sand dam (FOR DAM SITE) Crosstabulation

			status/condition of the sand dam (FOR DAM SITE)				Total
			Dam has failed	Dam is functioning well	Dam has a leak	Dam is still maturing	
Age of the dam	9	Count		1			1
		% of Total		3.3%			3.3%
	8	Count		4	1		5
		% of Total		13.3%	3.3%		16.7%
	7	Count	1	3			4
		% of Total	3.3%	10.0%			13.3%
	6	Count		1			1
		% of Total		3.3%			3.3%
	5	Count		4	1		5
		% of Total		13.3%	3.3%		16.7%
	4	Count		1	1	1	3
		% of Total		3.3%	3.3%	3.3%	10.0%
	3	Count		5	1	2	8
		% of Total		16.7%	3.3%	6.7%	26.7%
	2	Count				1	1
		% of Total				3.3%	3.3%
	1	Count				2	2
		% of Total				6.7%	6.7%
Total	Count	1	19	4	6	30	
	% of Total	3.3%	63.3%	13.3%	20.0%	100.0%	

**6.8. Capacity of the Community to Prevent Silting**

To ensure that the dam matures to a sand dam, complimentary activities to prevent silting are a prerequisite. The study establish that although SASOL conducted trainings on natural resource management, there is either a knowledge and practice gap or inadequate knowledge on the impact of soil erosion on dam maturity. Establishment of evidence of plant cover on the sand dam banks and terracing and trenching on the *shamba* owned by interviewee confirms this. Out of the 30 dams visited, 43% of the dams had their banks unprotected, another 43% had banks protected on one side only and only limited number, 13% of the dams had plant cover on both sides. The dam that failed had its banks unprotected. Similarly 65% of the households had extensive and well-maintained terraces, 18% poorly maintained and limited terraces and the remaining 18% had no terraces. Out of the total household without terraces, 5% are the near the dam site, which exposes the dam to great risk of silting.

**Table 20: Evidence of plant cover on sand dam banks**

	Frequenc y	Percent

No evidence of plant cover	13	43.3
Evidence of plant cover	4	13.3
Evidence of plant cover but on one side	13	43.3

L

**Table 21: Location of household within the village \* Evidence of terracing and trenching on the shamba**

			Evidence of terracing and trenching on the shamba			Total
			No evidence	Yes, extensive and well maintained	Yes, limited and poorly Maintained	
Location of household within the village	Near the dam	Count	9	40	11	60
		% of Total	4.8%	21.4%	5.9%	32.1%
	Intermediate distance from dam site	Count	12	38	8	58
		% of Total	6.4%	20.3%	4.3%	31.0%
	Far from dam site	Count	12	44	13	69
		% of Total	6.4%	23.5%	7.0%	36.9%
Total	Count	33	122	32	187	
	% of Total	17.6%	65.2%	17.1%	100.0%	

### 6.9. Capacity of a Community to Utilize a Sand Dam to Realize the Benefits

The training offered by SASOL to the community is limited to dam construction and did not include the post dam period. This was confirmed by SASOL, the sand dam construction committee and the interviewees at the household level. This is made worse by the fact that, after the dam construction there is little or no further contact between sand dam community and SASOL. As a result, the community is not equipped with adequate knowledge and skills to enable them utilize the dams to full potential even when the dams allow increase in water. The following capacity building gaps were established during the study:

- Recognizing the economic value of water as a scarce resource.
- Sand dams as an inspiration for innovation at the household level.
- The adoption of improved farming practices.
- An understanding of resources inter-relatedness.

### 6.10. Recognizing the Economic Value of Water as a Scarce Resource

It was observed that the only known crops that could be grown under irrigation are vegetables and fruits. Sukumawiki (kales) and tomatoes are the most commonly grown vegetables. There were however a few isolated cases of farmers growing onions and spinach. All the farmers growing vegetables, except one farmer who has a drip kit, use bucket irrigation and water vegetables every day. There was limited evidence of mulching explaining the reason for watering vegetables daily. As a result, lot of water was used to grow very little amounts of vegetables. Tree nursery for groups and individual household were also evident.

Reports from the community confirmed that water does not take the community to the next season which is the essence of the dam and that the dam does not sustain tree nursery and

vegetables during the drought. For most of the dams water is available up to the month of September denying the community vegetables during the most critical months of October and November. As a result, the dam does not meet the desired goal for making water available during the dry season and Household return to the old water sources nullifying the already realized success.

### **6.11. Sand Dams as an Inspiration for Innovation at the Household**

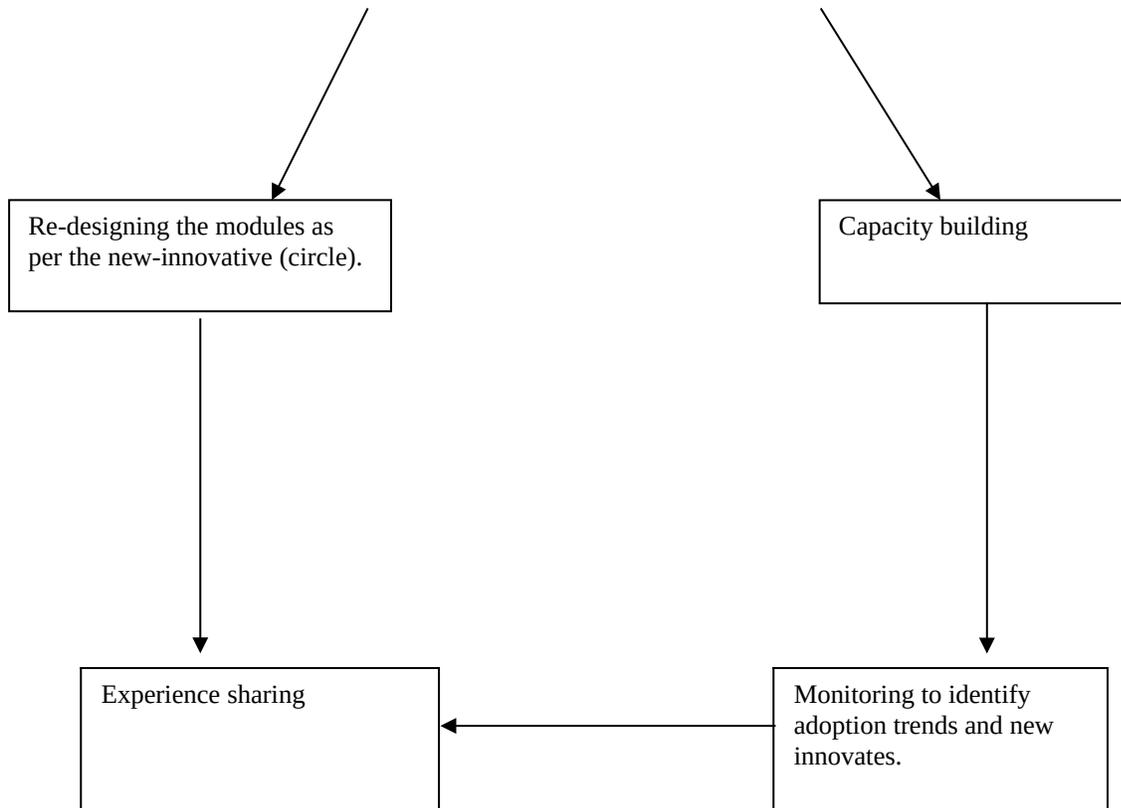
Considering that Kitui district is prone to drought and that need to increase water is paramount, participation in construction and presence of a sand dam within the village should promote community's understanding of sand dam paradigm as a water harvesting technology, motivating them to experiment and adopt the technology. The study however established that there was limited evidence showing that people in selected households were experimenting with new ideas and technologies related to the potential for irrigation observed at a sand dam. For example, some households were investing in donkeys to enable fetching more water as a means to irrigation in the home garden. A few farmers had planted grass in gullies to slow the flow of water so as to allow the growing of bananas. In other cases, sand bags were observed as a mini-sand dam on farms. Also, in two villages private sand dams were being constructed close to their homes. Similarly, there has been an increase in the number of private wells constructed.

Despite the above, adoption of innovation is still low among the sand dam community. This could be attributed to the fact that the community is not facilitated to form forums that provide opportunities for experience sharing through discussions and exchange visits. The inadequate monitoring and evaluation on the side of SASOL and the community denies both of them the opportunity to identify trends in adoption of innovations, sharing of experiences and replication of experiences shared. This calls for a need to design a training module that allows for farmer to farmer visit with special emphasis on importance of monitoring and evaluation of technology adoption, identifying the trends on adoption and facilitate sharing of experiences among farmers.

Both SASOL and the community should build strong cases and include them in the module for farmers training on technology adoption. It is sad to note that the dam that failed completely had no bank protection and that gullies on the land adjacent to the dam were evident yet no action was taken 7 years down the line. Had the community visited other dams, maybe they would have appreciated the importance of terracing and bank protection, reducing the risk of losing the expensive investment (dam). It is important to appreciate that sand dam as an inspiration for innovation at the household is a process to be worthy investing in (*see the illustration in Flow Chart 1*).

*Flow Chart 1*

Identification and development of appropriate training module on technology adoption.
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### 7.0 Entry Point into the Community

In most cases SASOL's point of entry to a village was via the Chief and sub-Chief to the village elder. This approach does not foster community ownership of a sand dam as the decision-making process comes down to the village through existing administrative structures. Dam construction committees were struck by whoever chose to attend a village meeting convened by the village elder on the urging of the Chief, sub-Chief and SASOL. This approach has led to a perception in some villages that constructing a sand dam is SASOL's idea, not their own preferred solution to the primary problems faced in the village. A related issue is SASOL's role in locating the site of a dam. If the location is not where they traditionally sought water in that stream or it is located inconveniently from where the people live, the interest in and sense of ownership of the sand dam constructed tends to be relatively low.

SASOL's point of entry into a village starts with a meeting with the chiefs, assistant chief and the village elder to market the sand dam paradigm. The village elder in turn organizes a meeting between SASOL and the potential sand dam community to further market the paradigm and initiate the process of constructing the sand dam. A survey along the river is done and possible site decided upon by SASOL and the community representatives. Upon agreement on the sites, community is requested to form a committee to supervise the dam construction. The roles and responsibilities of both SASOL and community are discussed and the construction starts.

The entry point is not without shortcomings. Although water is one of the most essential commodity in the entire Kitui district, occupying priority one in most development projects, the decision on which intervention to use lies with the community. In situations where a development agency has developed an intervention that has a potential to alleviate water

shortage, as is the case with SASOL then enough time should be given to the social marketing phase. This will ensure that the community understand the proposed technology fully and agree invest in the technology.

Discussions with the dam committee and the community members present during the onsite visit revealed that the entry point was hurried and the message moved from the Chief to Assistant Chief and then to the community who simply said yes to the idea without seeking to understand what is the sand dam technology. As a result, the idea for constructing the sand dam remains largely with SASOL; the community has not yet conceptualized the idea nor do they own it.

The formation of the committee was done hurriedly also, selection depended on who attended the meeting on the material day, denying some better alternatives on opportunity to ideal the group into constructing the sand dam. Information gathered shows that committee lack vision.

In a number of dams dissatisfaction on the location of the dam was reported. Traditionally, the community collected from particular places “misiyuko” which was easily accessible to both animals and people. Locating dams in other places has denied the community access to the water as the owners of the land adjacent to the dam have not provided a road leading to the dam.

The need for water is paramount. This need acts as a driving force for SASOL to contact both communities that expressed the desire to constructing water and those that have not expressed the desire to construct a dam. This notwithstanding SASOL should put more focus on the community other than the administration. Once the Chief and the Assistant Chief are informed, the community leader should take the lead role.

## **8.0 Community Participation**

Participation is a process through which the stakeholders can contribute to influence and share control over development initiatives and over the decisions and resources that affect them.

### **8.1 Planning the Construction of a Sand Dam**

During the design phase of the solutions to the problem of water, SASOL had already pre-defined the technical solution limiting the community decisions making on the choice of technology. This followed the common practice of NGOs where communities set problems and NGOs offer solutions to these problems. The sand dam option is the single offer, offered by SASOL to the community. The communities agree to provide labour needed, stone, sand, blast, water, food and accommodation for the artisan. SASOL provides technical assistance (trained artisans), cement and reinforcement bars that are assumed to be beyond the resources of the local community. The community participation is limited to providing local materials labour with aim to construct a new already defined facility. During the initial start-up of construction, the community does not understand what goes into construction of the sand until the construction starts.

According to the artisan, the construction should not take more than three months. As a result, the community is “pushed” to continue supplying the local material and labour and keep up with the artisans who in most cases have already plans to start-up another dam with a different community.

Community dropping out during the construction period was evident. In some dams the dropout was high as 90% leading only 10% to continue with the construction. In an attempt to complete to complete the dam as per schedule, more pressure was felt by the small

number continuing with the construction. As a result, constructing the dam was described by the sand dam community as “very hard” and too much work. When asked whether they would wish to construct another dam there were cases where the sand dam community said they would not want to be involved in construction of another dam. The situation is worse if the community has not realized any benefits from the dam.

For the communities that have realized the benefits, as is demonstrated by dams with water for household consumption and other uses, increased water has allowed increased production and supply of fruits and vegetables, brick making livestock production to variety of and increased income enabling the household to buy the staple food. In these dams the benefits realized represents a level of pay off that justifies this large investment.

## **8.2. The Timing of Dam Construction**

The most appropriate time of the year to construct a sand dam is during the dry season. For Kitui district, the dry season extends from May to October and food shortage is a common phenomenon. The community has to put together their meagre resources to provide food for the family. Young men, girls and able bodied men usually migrate to towns to seek employment. A majority of the households are left under the care of women and old men.

Dam construction requires community participation in terms of labour, time and money to pay for the artisan’s accommodation and food. The requirement is at a time when the community resources are overstretched and majority cannot afford to contribute time, money or food. This limits the ability of some members to participate in dam construction and subsequent use of dam. The advantaged sand dam community members able to continue with construction during this difficult period were found using the inability of them as an excuse to restrict access to water. The initial time put to construction and reasons for dropping out were not considered. This has become a source of conflict within the community. The contributions of households who participated initially, but withdrew for practical reasons such as a need to find food or to plant crops with the onset of the rains, need to be recognized. A failure to do so will make it more difficult to promote cooperative activities in the future.

The committee explained that to ensure that all willing members of the community participate without feeling being pushed, sand and stones should be collected and stones broken to size prior to the start of construction. This reduces the length of time required to construct a dam and opens the possibility of working in shifts rather than daily. Working in shifts also will allow time for the members to attend to other household activities especially looking for food.

Construction of sand dam often starts after the short rains when community is harvesting (May to July) and spills over to land preparation and planting time prior to the long rains, which is the main rain that communities depend on. Timely land preparation and planting is therefore a prerequisite. Participating communities often opt to drop out from dam construction and attend to farm activities. Working out a construction schedule between SASOL and members of the community that recognizes competing labour needs during land preparation and planting and during harvest will increase the possibility of timely participation by all members of the sand dam community.

SASOL should explore possibility of collaborating with other organizations that are involved in similar work or complimentary activities that enhance dam maturity and work out a strategy to support community during the dam construction. During the study, potential organizations like ADRA, World Food Programme were identified. With proper planning, these organizations would provide food and facilitate the community to construct the dam as a community food for work project

### **8.3. Evaluating the Cost of Dam Construction**

As discussed earlier in this section, the initial contact between SASOL and the community did not allow enough time for the community to understand what constitutes a sand dam, and what it takes to construct a sand dam. The message on importance of sand dam as a water harvesting technology and subsequent construction reached the community from SASOL through the Chief and village elder who simply recited the message received to the community. The community acted on the message received without questioning and understanding. They were just “told” as they expressed.

Community participation was limited to providing the local materials (sand, stones and water), food and money to support the artisan while SASOL provided financial support to pay the artisan, cement and reinforcement bars, which, according to them, was out of reach for the community. The actual cost of what each of the two partners provided was not calculated and discussed. As a result, the community thought that their contribution was inferior and had no value attached to it. This was evident during the discussions with them. They repeatedly said that we did not contribute anything we only “worked”. In contrast, contributions made by SASOL were valued highly and took the central place of the entire dam construction. Not wanting to lose this important contribution, said to be above their reach, the community submitted to the instructions given by SASOL through the artisan on the need to construct the already defined structure. This, in turn, has reduced their sense of ownership of the dam. Evidence of non-committal to maintaining the dam and the well is a result of not owning the assets. The perceived owner, SASOL, is expected to repair and maintain the dams and the well. This calls for a need to discuss the concept of cost sharing with the sand dam community and cost all the inputs provided by both SASOL and the community. An explicit costing of all inputs to the dam construction would focus attention on the magnitude of the community investment and highlight the important contribution of the community to the realization of this community asset. This in turn will foster community ownership of the assets resulting to repair and maintenance of the said assets. The community will also appreciate the need to implement the complimentary activities that enhance maturity of the dam and subsequent realization of the benefits which is the ultimate goal of constructing the dam.

### **8.4. Community Leaders as an Important Variable in Sand Dam Success**

As stated earlier, SASOL’s entry point to the community is through the local administration. The initial message from SASOL to the community is passed through this community structure. The initial start-up of the project which starts with the formation of the committee depends on how well the leaders are able to communicate the messages to the community. Formation of the sand dam construction was spearheaded by the village elder who was charged with the responsibility of mobilizing the community around the proposed dam sites and subsequent selection of the committee. In most cases announcement to attend the meeting either did not reach the village members or were not understood. As a result, not all members of the village attended the meeting. Selection of the committee was done by those present denying visionary member an opportunity to lead and denying the village good leaders.

Discussions with the committee revealed that SASOL did not give clear guidelines and majority of the community members seem not to know how the process of recruiting dam committee members was done. Generally the difference between nomination, selection and election is not clear to all. Low frequency of dam committee meeting was reported especially after the dam construction. Lack of clear guidelines and understanding of how to elect a good committee facilitated putting community members without a vision for the sand dam in office. This has impacted negatively to the community and has adverse effects on the maturity of the sand dam. Where community elected good leaders as is evident in some of the dams, the committee facilitated the community to implement activities that

enhanced the maturity of the dam specifically the protection of the banks. Existence of such committee after dam construction is evidence of some leadership.

### **8.5. The Continuing Role of a Sand Dam Committee**

The success of community project depends on the ability of the leaders to facilitate the community through the entire process from design, implementation and ensuring project sustainability. An active committee that continues to guide and serve a sand dam community after the completion of the concrete and stone sub-surface barrier is essential to continue community activities required to allow a sand dam to mature and to keep it relatively free of contamination so that it provides a source of water that addresses the human, livestock and agricultural requirements of the sand dam community that constructed the dam.

To ensure that the committee carries out their task effectively, a capacity building module for the committee needs to be inbuilt within the sand dam construction model. This will ensure that committee is fully trained and conceptualizes the entire programme. The structure of the training in place does not allow training of all committee members. The few individuals who have an opportunity to attend gain very little during the training. Both the natural resource management and the sanitation and hygiene training are too intensive to allow full understanding and contextualization of the issues in question. As a result, the committee members are not able to guide the community implement the activities necessary to allow the dam to mature. Lack of follow-up by SASOL to ensure that messages passed are accurate and to identify gaps and fill them also denied the community understanding on the importance of enhancing the maturity of the dam and their future role as members of the sand dam community.

### **8.6. The Value of a Strong Community Spirit**

Communities in Kitui have a strong community spirit build around the self help groups referred to as “Mwethya” groups. “Mwethya” groups are traditional in the area and majority of them are registered with the Ministry of Culture and Social Services. These groups have been the backbone of most community activities ranging from terracing, water projects, road construction, funerals, dowries construction of houses and most farm activities among others. These well organized groups count a lot. The sight of a hundred or so people digging terraces or constructing a sand dam and singing at the same time is not only impressive but also motivates the community to keep the spirit going. Considering that construction of the sand dam is referred to as “very hard work”, any investment in efforts to strengthen the already existing groups and build their capacity to fully understand the sand dam technology will be paid back in form of more cohesive groups that together will implement the complimentary activities enhancing the maturity of the dam.

## **9.0 Collaboration and Networking**

### **9.1 Promoting Collaboration among Development Agencies**

The study identified the following development organizations and some government ministries active in related activities in the same communities served by SASOL. AMREF, JICA, ADRA, CCF, Kitui Development Centre, formerly World Neighbors, Catholic Diocese of Kitui, Kitui Agricultural Project, Ministry of Health and Ministry of Agriculture. There was some evidence of collaboration between Ministry of Health and Kitui Development Centre but not with the other organizations. Collaboration between these development organizations is essential to avoid confusing local people, and to ensure better planning and more efficient use of resources. SASOL’S policy of collaboration with other organizations and government departments is not clear. The study established that in some villages up

to five government ministries and NGOs were active in related activities but each seemed to work independently without letting other projects know what they are doing.

There was no evidence of attempt to meet to coordinate activities and in some villages; there was overlap of activities with projects doing the same thing in the same area. A case to mention is DAM 730 where AMREF, Catholic Diocese of Kitui and SASOL were assisting the same community construct sand dams on the same river. From an outsider's eye, there seems to be competition between the organizations making the community more confused. The competition does not allow for proper community mobilization as each project tries to attract more community members. As a result, projects supported by the various organizations are not owned by the community and are named after the supporting organization. On one of the catchments visited, there is SASOL'S sand dam, AMREF'S sand dam and Catholic sand dam. It is also worthy noting that the competition among these agencies limited focus on a comprehensive development strategy that was able to build on the potential presented by a sand dam. There is a need to analyze the training received to establish the key stakeholders. Comparing message implementation, reinforcing versus single messages, builds a case for a need to collaborate and network

## 9.2 Building on Strengths of Other Organizations

The study established that each of the organization identified have their own unique strengths that if properly exploited would form a rich information base where each organization builds on the other for example SASOL is strong in dam construction, AMREF capacity building in sanitation and hygiene, JICA Agro forestry, CCF food security, Catholic Diocese community organizational structure while government ministries give guidance on government policy. Considering that SASOL's contact with the community is only during dam construction and that other players have longer contact with the community both during the dam construction and after the available specialties need to be coordinated. Collaboration during the entire process would help/ facilitate the community understand the messages better. This is evident by the above information that shows that construction of pit latrine and boiling water was more re-enforced resulting in increased practice. Given that SASOL lacks capacity to address all aspects of agriculture and rural development related to water, promotion of collaboration among agencies should be considered as a way forward.

## 10.0 Monitoring and Evaluation

### 10.1. Follow-up Contact after Sand Dam Construction

The functioning of the dam committees which is the supreme authority of the sand dam community seems to have ended when the construction of the stone concrete wall across the river bed was completed. Likewise contact with SASOL seems to have ended at the same time.

There was limited evidence of contact between SASOL and a community after the completion of dam construction. For example, villages in which dams had been constructed in 2002 or thereafter reported SASOL had promised an enclosed well with a pump. Only one village reported following-up on this promise. Lack of follow-up by the community is attributed to inadequate leadership. 40% of the committees were disbanded after dam construction, 34% still exist but have limited impact and only 26% are in existence and active (see table 22).

**Table 22: Percent distribution of status of the sand dam committee**

Status of dam construction committee	Frequency	Percent
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Committee disbanded after dam construction	74	39.6
Active committee in existence	49	26.2
Committee still exists but has limited impact	64	34.2
Total	187	100.0

Another factor probably influencing this is the relative short period in which SASOL and the community is working together. The community seems to have spent more time with the artisan than any other SASOL staff. Discussions during this time of contact revolved around construction and very little on project management including importance of follow-up. Lack of follow-up after completion of the dam has impacted negatively on the project. Issues needing attention for instance dams not maturing due to silting. Leaking dams' wells without lids and repossessing of wells dug on individuals land among others have gone unnoticed. Corrective measures have not been put in place and as a result the communities have not realized the expected benefits.

### **10.2. The Need for Project Monitoring and Evaluation**

Considering that water is essential for the households in Kitui to function especially during the drought and considering that the sand dam technology is extremely beneficial to farmers in the region, there is need to measure its impact and to develop an adequate reporting system. The documented impacts facilitate calculation of the cost and planning for the future. Experiences from successful projects are used as leanings for both new projects and the already implemented projects that have not realized the expected benefits.

An effective system of monitoring and evaluating the maturing of sand dams was not in place. A failure to monitor and evaluate community follow-up activities after the construction of a dam reduced the realization of the overall development impact of dams' construction. Only 47% of the dams were reported having water for household consumption and other uses. To be precise it only communities served by these dams that have realized some benefits from the sand dam. Considering that dams are expensive to construct both by SASOL and community, realizing the expected benefits is the joy of all. It is sand to note that omissions that could have been rectified to facilitate maturity of the dam and ultimate realization of the benefits have not been attended to. As reported earlier, experiences from dams both the dams that had matured and dams that had failed were not shared. As a result majority of the sand dam community does not understand what constitutes sand dam and are not aware of the actions needing to be taken to ensure that the dams mature as expected.

### **11.0 Conclusion**

A Sand dam is one of the greatest investments that communities in need of water can invest in. A well planned and implemented sand dam project that does not only facilitate construction of a stone concrete war across the river bed but also ensures that the community implements complimentary activities to enhance maturity of the dam as expected will certainly realize the benefits of improved food security and good health. This is a basic requirement for all human beings.

ANNEX C

An Assessment of the Strengths and Weakness of the Organizational and Environmental  
Aspects of the Sand Dam Paradigm

by

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**September, 2005**

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## **1.0 Introduction**

Given the team's observation of a representative sample of existing dams built with the aid of the SASOL Foundation, it was determined that the sand dam paradigm, as implemented by SASOL in cooperation with dam communities, merited further funding and implementation. This conclusion was based on the recognition of both the concrete benefits derived from a dam by a number of dam communities, and the potential benefits for other communities who had as yet not, for varying reasons, realized them.

It would be remiss to suggest that this constitutes a hearty endorsement of SASOL's approach and performance in implementing the dam paradigm—frankly put, the track record of the dam project is desultory. Of the nineteen dams in the sample constructed prior to 2002, thirteen are currently experiencing problems with silting,<sup>12</sup> and in seven of those thirteen the problem was serious enough that the viability of the dam had been compromised. In effect, 37% of the dams that the team visited (a number that may be applied to all SASOL dams, if our sample was truly representative), that had been given time to mature or nearly mature, were either failing, in danger of failing, or in one case, had already failed. This figure doesn't capture the significant number of immature dams that, given the lack of proactive measures taken on the part of their communities, were destined for failure or a life of marginal utility.

The clearest cause among the many complex, interlocking, and often unique sources of failure of communities to realize appreciable benefits from their investment of time, energy and money in constructing a dam, was SASOL's failure as an organization to facilitate and ensure a sense of ownership of the dam on the part of the dam community. SASOL needs to communicate effectively and reinforce essential lessons regarding the nature of a sand dam and its care and maintenance, and to understand its responsibility to both donors and dam communities to follow-up on constructed dams, both through a system of monitoring and evaluation and by continuing to partner with communities post-construction to ensure that proper steps are taken to facilitate maturation of a stone and cement sub-surface barrier into a fully functioning sand dam. The bulk of my report will be spent in expounding upon these conclusions, both in an effort to fully analyze breakdowns as well as to provide thought for possible means of addressing these shortcomings in the future.

Recognition should also be given to the significant successes of the sand dam paradigm. In dam communities that had succeeded or largely succeeded in protecting the streambed from silting, the dam was consistently observed to have made a significant contribution to the well-being and quality of life in those communities. Evidence was various: increased cultivation of fruits and vegetables leading to increased household income as a result of their sale and increased consumption, which resulted in improvements in the health, nutrition, and consequently school performance of children; the freeing of significant time for women, which was invested in improving the productivity of their farms and beginning or expanding small business ventures, among other things; and increased biodiversity in dam communities due to the improved prospect of survival for non-indigenous tree and grass species, as well as the greening and increased fecundity of the region surrounding the dam site due to the elevation of the water table. These outcomes and impacts were both broad enough and profound enough across the sample to justify further investment by SASOL and potential donors in the sand dam paradigm.

## **2.0 Exploring Positive Outcomes and Impacts of the Sand Dam Paradigm**

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<sup>12</sup> The presence of silt precludes the accumulation of sand within the streambed, thus severely impairing its ability to capture and conserve water for future use.

In this section the evidence of specific positive outcomes and impacts of the sand dam paradigm within dam communities are analyzed in greater detail. Specifically, the evidence of increased opportunities to establish small business ventures or other income-generating activities, the decreasing need for young men to migrate from their villages as a result of those increased economic opportunities, and the surge in biodiversity in dam communities due to the increased availability of water and elevation of the water table in and around the streambed.

## **2.1 Increased Business Opportunities**

In those communities that have realized sand dam maturity, and, as an outcome have experienced greater water availability, one notable impact has been the increased opportunity for individuals and households to create or expand small business ventures and thus generate additional, sometimes vital income. This is particularly important in the communities of Kitui District, where uncertain rains mean uncertain harvests and having a supplementary source of income can be the difference between getting enough to eat and having to sustain a family on one meal a day for a period of two months or longer.

Most notably, the increased availability of water as a result of the dam has led to more widespread (and in some cases quite extensive) fruit and vegetable cultivation in communities with functioning sand dams. This outcome has had a number of business-related implications, the most obvious being that fruit and vegetable growers are able to sell their surplus<sup>13</sup> harvest at both the village and market level, thereby generating income that can be used toward school fees and household goods during periods of abundant harvest as well as saved to purchase food when rains fail and harvests are lean. In addition, increased fruit and vegetable cultivation has given rise to entrepreneurial ventures at the village level, particularly the rise of middlepersons (generally women) who purchase produce wholesale in their communities and then sell it retail in local town markets (and in one case as far away as Nairobi).

The increased availability of water also has resulted in the advent or expansion of tree nurseries within dam communities. Individuals and groups with nurseries are able to both plant and sell seedlings that they have cultivated, with positive implications for the biodiversity of the community and the income of nursery tenders.

Third, increased water availability has led to a surge in brick-making, both for retail and personal use, in communities with functioning dams. As noted below, brick-making is an especially favored activity among young men, who have the time and physical strength to perform the demanding labor. Brick-making is both a source of income when bricks are sold retail, and a means of saving income, as when personal construction projects utilize homemade bricks that otherwise would have been purchased outside of the household.

Finally, time women save as a result of having a consistent source of water close to the household<sup>14</sup> has engendered several business opportunities that had heretofore been largely infeasible, including the aforementioned rise of a small “class” of middle-persons in the fruit and vegetable trade. In addition, women have also recognized the opportunity presented by playing that same middle-person role but in the opposite direction—i.e. buying fruits and vegetables (primarily varieties that are not otherwise available in their communities) in the town market, and then retailing them at home, often at fair prices.

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<sup>13</sup> In reality, because vegetables aren't regarded as staple crops in most communities, households are more inclined to sell off rather than to consume the bulk of their harvests in order to procure income for the purchase of staples, even in cases where the economic logic for such a practice is negligible or nonexistent.

<sup>14</sup> Preliminary data suggests that the time saved in fetching water as a result of the existence of a dam is significant, i.e. about three hours each day.

Furthermore, instances were noted where women had begun small roadside kiosks, teashops, produce stands, etc., as a result of the loosening of time constraints permitted by the ready availability of water. Finally, women have also utilized this additional time to begin or expand the practice of weaving baskets from the fibers of the sisal plant for retail or personal use.

## **2.2 Migration Effects of a Dam as a Result of Increasing Economic Opportunity at the Village Level**

A major concern among rural communities in Kitui, as in much of Kenya and the whole of the developing world for that matter, is the migration of young, working-age men from the village to towns and cities because of the paucity of economic opportunity available within their home communities. The existence within communities of functioning sand dams has served to partially stem this outflow of young men, given their realization of adequate and sustainable income-generating activities flowing from the increased availability of water within these communities. Overwhelmingly, these activities have taken the form of vegetable cultivation and brick-making. In some communities young men without access to prime land close to the dam and streambed had even gone as far as to lease that land from its owners and were reaping significant economic benefits as a result.<sup>15</sup>

## **2.3 Increased Biodiversity**

One means by which successful dam communities have experienced increasing biodiversity has been due to their improved capability (given a ready supply of water) to raise and nurture seedlings during the crucial early stages of development, thereby allowing the diffusion of exotic tree species, particularly fruit trees, in a region that has not typically been hospitable to such varieties. In addition, other non-indigenous species are serving as sources of firewood and fencing, and expanded tree planting is the first step toward reforestation and perhaps future climate change within these semi-arid communities. Many communities have also planted napier grass as a means of soil and water conservation, both along the streambed near the dam and along terraces and beds on private land—a further example of the introduction of a new plant species directly attributable to the effect of increased water availability within dam communities.

Additionally, a unique form of expanded biodiversity has occurred, not as a result of any conscious effort on the part of communities, but rather through a natural greening process stemming from the dam's elevation of the water table along the streambed and surrounding land. Soil once hospitable to only the hardiest of species has become increasingly receptive to less tenacious forms of flora. A number of communities noted the presence of new species of indigenous plant life in, along, and near the dam and streambed, including unfamiliar varieties of grasses, shrubs and trees. In one of the more dramatic examples, two communities in South Kitui, among the driest we visited, noted the (in one case prolific) growth of the castor seed plant within the streambed following dam construction, a largely unprecedented occurrence in that region.

## **3.0 Understanding Gaps and Breakdowns in the Paradigm**

As was implied in the introduction, SASOL faces a formidable challenge to retool and, in some cases, reshape the sand dam paradigm in order to better ensure that dam communities are equipped to guide a dam to full maturity and thereby realize the full spectrum of benefits that a sand dam can offer. Chief among the breakdowns in the dam paradigm have been the failures to facilitate full community ownership of the dam, provide

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<sup>15</sup> It should also be noted that a frequent refrain heard among communities was that the young men had left to look for work, and finding none, had been forced to return to the community. Given the existence of a more favorable job market, it is possible that the observed reduction in out-migration of young men from successful dam communities would have been tempered significantly.

sufficient and proper education of dam communities in both the nature and functioning of a sand dam and the measures necessary to ensure its full maturation, and the failure to maintain an active presence in communities post-construction in order to monitor the progress of the dam and community efforts towards its protection and maintenance. Below I address these concerns individually in order to provide a more comprehensive analysis of the challenges facing SASOL in reforming the sand dam paradigm, the ultimate hope being better service to the communities in which they work.

### **3.1 Ensuring Community Ownership**

It seems a truism to suggest that micro- and community-level development projects must be owned by the communities in which they are being implemented; that is, communities must understand that it is *they* who possess *ultimate* responsibility for the success and failure of a project, and it is *they* who must bear the brunt of the burden in bringing a project to fruition. This has been a *priori* thinking in development for decades. Facilitating community ownership of development initiatives, however, has proved easier said than done, and SASOL's work with sand dams in Kitui has been no exception. One should not take this to mean that facilitating community ownership and participation in development is impossible, only that it can be as much, or even more work than implementation of the development project itself.

At each stage of the implementation of the sand dam paradigm, SASOL has missed vital opportunities to facilitate and reinforce community ownership of, and participation in the project, from the point of initial contact with the community to the actual construction of the stone and cement barrier.<sup>16</sup> Community ownership *must* be built in at each stage in order for the sand dam to realize maturity, and for the community to realize the benefits flowing from that maturity. Few were the communities, who, whether by accident, dumb luck, or divine providence, were able to realize appreciable benefits from their dams in absence of the measures of care and protection that are the hallmarks of community ownership.

#### *3.1.1 Entry Point to the Community*

SASOL's choice of entry point into potential dam communities (as well as its decision to approach communities who had not necessarily expressed either interest in constructing a dam or difficulty securing a sufficient supply of water), generally through the Chief or sub-Chief at the sub-location level, does not effectively involve stakeholders within the community in the initial decision-making phase of the project. Word moves from SASOL, to the Chief or sub-Chief, to the village elder(s), who in turn pass on news of SASOL's proposal to whatever community members are receptive to the message. No matter how perfectly the message is transmitted along the way, the fact that it is passed downward through a hierarchy of officialdom to the community cannot be changed, and therein lies a significant part of the problem.

Does a community say no to its village elder(s)? Maybe. But the sub-Chief? The Chief? Does it say no to free cement and construction materials? SASOL's choice of entry points has created a captive audience of subjects at the community level who, from the beginning, have little or no idea what a sand dam is, how it works, and whether a dam should be built in their community—the decision, in effect, has already been made. And how does a

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<sup>16</sup> Ironically, SASOL's determination to wash their hands of the dam following construction, an ultimate sink-or-swim test of ownership, is not only ill-advised in consideration of their prior failure to build ownership into the process of implementation, but in terms of sustainability as well—many is the tale of the NGO who enters a community, "completes" a project, and leaves, never to be heard from again—meanwhile the community is left to ponder why they should care to protect or maintain the NGO's investment when the NGO itself has not even taken the time to maintain contact with the people and communities it is purporting to want to help.

community mobilize around and own something of whose existence and purpose it has only the vaguest understanding?

It seems SASOL would be better served by entering the community through the village elder and/or other stakeholders and leaders at the community level. This is not to suggest that the Chief or sub-Chief be circumvented entirely; in fact, it seems SASOL has some legal obligation to obtain the official approval of the local authorities, but there seems to be no compelling reason requiring SASOL to make initial contact with government officials rather than community leaders. Preliminary entry at the community level would increase the likelihood that dam construction be viewed as a community decision, rather than an administrative or NGO one.

Furthermore, in ideal circumstances, SASOL would only contact communities that had expressed either the desire to build a dam or difficulty in securing water; along with ensuring that initial contact be made at the community level, this would largely eliminate the propensity for communities to view the dam as SASOL's initiative and SASOL's idea, which has served to undermine ownership and participation.

### *3.1.2 Project Planning Stage*

It is imperative that the community plays a significant role in planning dam construction, not only to reinforce ideas of community ownership and promote participation, but also, in practical terms, to avoid conflicts that may impair the timely and successful completion of the dam, conflicts that may only be apparent to members of an individual community. It seems that communities have had reasonable input into the selection of the dam site—or at the least they are taken through a pantomime of a democratic selection process—but in terms of shaping the construction plan and schedule, their contribution appears to have been minimal. This has served both to undermine ownership and, just as importantly, has had an adverse affect on the full participation of communities in construction and by extension dam use (indirectly weakening ownership given that strength, as the saying goes, is in numbers).

Many of the communities that were part of the sample noted that during the course of construction their labor pools had dwindled significantly,<sup>17</sup> typically for one of three reasons: The lengthening of the dry season forced many to seek casual employment or other means of procuring income to purchase food; the onset of the rains meant that farmers had to choose between continuing construction or preparing their land for planting; or, less frequently, construction conflicted with harvesting. Although some conflict is unavoidable, the fact that so many communities reported a significant weakening of their labor force during the course of construction as a result of such conflict implies that they were not included, or only marginally so, when the decision on the timing of construction was made.

If communities, upon deciding to build a dam, were to plan, well in advance and in concert with SASOL, the timetable for dam construction, allowing them time to gather the necessary materials and clear pathways to the dam site (if necessary) prior to construction, as well as to have a understanding of when the dam should be completed so as to clearly enunciate potential conflicts with vital agricultural and income-generating activities, these conflicts might be largely avoided, and community participation and ownership facilitated in the process.

Such an approach may also obviate the need to rethink the widespread policy of restricting access to the dam and water to those in the community who complete the construction process. This policy has proven problematic because the timing conflicts that arise over the course of construction often mean that community members are forced to choose between

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<sup>17</sup> A 50% depletion of the labor force was frequently cited.

securing present and/or future access to food and securing future access to water. Those who fail to complete dam construction are therefore barred access to its water even when they have contributed, in some cases, 75% or more of the necessary labor. Should such conflicts persist into the future, it would seem essential for SASOL to revisit this policy in order to provide a fairer compromise for those forced into such lose/lose decisions.

A further step that might be taken at the project planning stage, or even at the decision-making stage, to promote community investment in the dam would be an honest, economic assessment of the cost of the dam conducted with the entirety of the community. The vast majority of dam communities had precious little understanding of the cost of the dam beyond, perhaps, the market price for a 50 KG bag of cement. Because community members were unable to attach a monetary value to their labor, as well as to the locally sourced materials and food that they furnished, they were likely to believe that their own contribution to dam construction was minimal in comparison with SASOL's provision of cement, metal bracing, the dam artisan, etc. Clearly this had a deleterious effect on whatever feelings of ownership and investment that may have formed over the course of dam construction. If communities are able to understand in monetary terms just how valuable (given the market rate for unskilled labor) their contribution of time and energy, as well as construction materials really is,<sup>18</sup> the possibility that they will view the dam as belonging to them, rather than to SASOL, would no doubt improve significantly.

Another difficulty stemming from a gap at the planning stage of dam construction centers on the lack of definition regarding the constitution of the banks of the stream—defining where private land ends and communal or public land begins. This became a major source of conflict in a number of communities after the dam had been completed when land owners grabbed land in the streambed for cultivation, thereby impeding the accumulation of sand, creating a source of silting within the bed itself, and thus imperiling the viability of the dam.<sup>19</sup> Another more common problem stemming from this lack of definition is the confusion surrounding who, landowner or community, bears responsibility for protecting the banks of the streambed from erosion through the seeding of Napier grass or a comparable substitute.

SASOL's policy of gaining the oral consent of landowners to construct the dam on "their" land and to permit access for the whole of the community to the dam, in many cases has proven insufficient to inhibit illicit advances into the bed on the part of landowners. If the banks and span of the streambed are clearly agreed upon and marked—either through a Ministry of Water survey or an informal community effort—and a written agreement, assuring respect of defined boundaries and full community access to the dam and bed, were to be signed by both landowners and a legally responsible party within the community, the incidence of this sort of encroachment and subsequent conflict would likely decrease, if not disappear altogether. Part of the agreement could also include an assignation of responsibility for the protection of the banks, which, should it fall to the community as seems probably, would further foster a communal sense of ownership of the dam.

### 3.1.3 Dam Construction Phase

A final point needs to be made regarding the role and presence of the dam artisan, or *fundi*, in the promotion of community ownership and participation in the sand dams project. A *fundi*, for the duration of construction, represents the most direct link between SASOL and

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<sup>18</sup> SASOL requires that dam communities contribute a minimum of 60% of the cost of every dam.

<sup>19</sup> In one case, the adjacent land owner, who also happened to be village elder, grabbed the dam *itself* and barred access to the streambed to other community members; in another instance, the community refused to construct a shallow well near the dam because they feared the adjacent land owner would fence it off and claim it for his own.

the dam community and therefore plays a vital role in promoting both participation and ownership of the dam. Because he possesses skills that are unique within dam communities, he is from the outset of construction set apart from the community. A relatively straightforward way to promote ownership in any development project requiring non-indigenous knowledge is to allow for partial or complete transfer of skills from specialist to community, but this transfer has been absent from the sand dams paradigm. Certainly the *fundis* have a right to be proprietary about their craft, but even a relatively small amount of intentional instruction in dam repair offered to only one or two members of the community would not only enhance community ownership, but would also have the double advantage of better preparing the community to maintain the dam in the event of a leak.

In addition to the possibility of facilitating a transfer of skills between *fundis* and community, further consideration must be given to the organizational role of *fundis* within SASOL. Because *fundis* are compensated for the entirety of the year regardless of how much time they spend engaged in actual work, it has been in SASOL's economic interest to keep them employed as close to year-round as possible—that is, constructing as many dams as possible—even if this forces communities into decidedly inauspicious construction schedules. This strikes directly to the heart of what seems to be the central question facing the sand dam paradigm: Quantity or quality? SASOL, admittedly, has to this point chosen quantity, and as the team observed, the quality of the outcome, in many cases, has suffered. If *fundis* need be employed throughout the year, it seems reasonable to suggest that SASOL, in the interest of promoting quality and facilitating the maturation of constructed dams, consider using them in capacities beyond simple construction. This possibility will be explored further in sub-section 3.3.

### **3.2 Extending Sufficient and Proper Education to Dam Communities**

One need not belabor the point that the role of educating communities in participatory development projects such as the sand dams project is vital—vital to participation, vital to community ownership, and ultimately, vital to the success of the project. Over the course of the survey, it became increasingly evident to the team that, given the pattern of inconsistent dam maintenance and maturation, as well as in recognition of a pattern of community response regarding fundamental questions of dam functioning and care, the training of communities in these essential points has been either incomplete, incompletely retained, or imperfectly communicated—or more likely some combination of the three. The consequences have been considerable and scarcely require enunciation; suffice it to say that communities that do not know, cannot do. Given this knowledge, a reappraisal of SASOL's training process seems a necessary first step toward resolving the noted deficiencies in its effectiveness.

#### *3.2.1 Communities' Failure to Conceptualize a Sand Dam*

Perhaps the most egregious example of the disconnect in training between SASOL and communities, and one that is all the more egregious for its fundamental importance, is the failure of a significant number of dam communities to understand both the true function of a sand dam and how its proper functioning is realized.<sup>20</sup> Simply put, communities did not recognize that the accumulation of sand in a streambed was just as important a piece of their realization of water security as their construction of a cement and stone barrier—that a streambed without sand was also a streambed without water.

Furthermore, even among communities that understood the role of sand in water retention, in many instances the knowledge of practices needed to facilitate the maturation of the dam—i.e., planting napier grass along the banks and terracing the land adjoining the

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<sup>20</sup> In a few instances, communities even believed that the dam was designed to trap water at the surface of the streambed: "Tell SASOL we need to build the dam higher," we were told on more than one occasion.

streambed—although having been communicated in training, were not clearly connected to, or sufficiently emphasized *vis à vis* the care of the sand dam itself. For example, in the day of training that I observed, terracing and planting grass, although noted as erosion prevention measures, were lumped together with other practices such as tree planting, constructing pit latrines, and fencing farm land against livestock, as generally good and forward-looking means of enhancing one's well-being and the health of one's environment. Because such practices are commonly lumped together, often without ample emphasis placed on the interrelation between salient practices and care of the dam, it seemed that trainees, left to pick and choose among the varying lessons that had been handed to them over the course of training, latched onto one or two that seemed most interesting and carried that, and that alone, back to their communities.

The same analysis applies to measures regarding dam contamination. Visible contamination of the dam site (in all but one case, contamination was synonymous with animal waste) was observed in 60% of the dams we visited, and although some communities admitted that they either had allowed rules prohibiting the presence of livestock at the dam site to lapse, or had never formulated or enforced such rules despite training in the matter, a surprising number evinced ignorance regarding the role of animal waste in water contamination. A further gap in training regarding potential contaminants, and one that may become increasingly important in the future, concerns the use of chemical pesticides and fertilizers, particularly on land adjacent the dam and streambed. Although the utilization of pesticides and fertilizers in Kitui District is minimal at the present, if vegetable cultivation continues to spread, it would not be remiss to suggest that contamination from their use might become a serious problem.

### *3.2.2 Structural Problems in the Training Process*

One must also analyze the structure of training in order to better understand why trainees have often failed to adequately absorb the essential lessons offered them. Training on Natural Resource Management—the heart of any instruction regarding dam care and maintenance—is conducted over four full days, the first day of which is composed entirely of introduction and a Participatory Rural Appraisal (PRA) of each of the communities represented in the training, a process which may carry over into the second, and even third days.<sup>21</sup> This leaves a considerably narrow window of time to impart what should be the most important part of the training process—how to ensure a stone and cement sub-surface barrier becomes a sand dam. Invariably trainees, many of whom have had little formal education, are bombarded with a disparate muddle of lessons—why pit latrines are necessary, why tree planting is important, how terracing increases the productivity of the land, why community cooperation is important, etc.—over the course of a few days and are subsequently expected, not only to retain most, or all of this information, but also to communicate the most salient points to their communities.

The training is simply too intensive to allow for full absorption of the essential lessons needed to properly maintain a sand dam, i.e., via proactive protection against silting and contamination. Furthermore, the absence of any sort of follow-up training on the part of SASOL contributes to the ultimate improbability that a community as a whole will adequately receive and retain the necessary instruction. Spacing the training over the course of several weeks—allowing time for full reflection, absorption, and communication on the part of trainees—would be one simple way of facilitating a more effective training process. A second measure, in regards to follow-up, would be to employ idle *fundis* as de facto extension agents reinforcing training messages in dam communities. This possibility will be discussed further in sub-section 3.3.

### *3.2.3 The Breakdown between Trainees and their Communities*

<sup>21</sup> I cannot corroborate this assertion with any concrete evidence, but this is the understanding I received from those familiar with the training; therefore, it may, in fact, be erroneous.

A final consideration that must be made in regards to the training of dam communities is the evident failure on the part of trainees to effectively or comprehensively communicate their training to the whole of their communities. This must be appreciated as another breakdown in the link of knowledge transference from SASOL to the community, one which, although heavily dependent on the motivation, leadership abilities, and pedagogical powers of individual trainees, might also be amended on SASOL's end by including in their instruction an intentional training of trainers focus; that is, individuals trainees might not only be instructed in the essential and complementary lessons regarding dam care, maintenance, natural resource management, etc., but also in training techniques, including how to mobilize their communities for training, which was an expressed difficulty in more than one village. It seems evident given the team's observations that SASOL cannot rely on community members to act as competent mediums for its message without first some explicit focus in the course of training on building their capacity as trainers.

### **3.3 The Absence of Follow-up and Monitoring in Dam Communities Following Construction**

SASOL has admitted, even prior to the completion of the team's work, that as an intentional policy, it has not followed up with dam communities after the completion of the dam structure, choosing instead to devote its limited resources to the construction of further dams. It is not my intention to debate the relative merits of this decision, but rather to explore its outcomes and impact on dam communities.

One result of SASOL's decision to eschew follow-up and monitoring has been the absence of any means of reinforcement for the lessons transmitted in training, which in some communities has meant that measures necessary for the care of the dam have never been taken, and in others an apparent loss of focus after an initial period of conscientious upkeep, ultimately resulting in the compromising of the dam's maturity. A second result has been that SASOL, without any system of monitoring and evaluation, has been entirely incapable of assessing the success of its efforts and dam communities' efforts to realize a true sand dam and thus water security. At present it lacks the ability to recognize how training has translated or failed to translate into action on the ground, to identify important gaps in project implementation, or to understand the community dynamics that contribute to or detract from successful implementation of their project post-construction. In other words, SASOL has no way of knowing how they are performing, how the communities in which they are working are faring, and what changes need to be made in order to better do their job and to help those communities.

Another troubling outcome has been a palpable diminution of respect for SASOL in some communities. Although communities were often reserved in their language, their disappointment and ill feeling were either implicit in their stories or communicated by other means. A little over one quarter<sup>22</sup> of communities that we visited as part of the sample claimed that SASOL had made promises regarding the construction of a well that it had not subsequently delivered on. Others expressed their disappointment in terms of a "SASOL told us there would be water, but there isn't" narrative. It was clear that, in many of these communities, SASOL was perceived as another in a long line of organizations that had entered their lives, made promises, mobilized support, and then left, never to be heard from again, apparently not caring whether those promises that they had made were ever realized.

SASOL's policy of withdrawal seems not only, at the very least, shortsighted, but also ultimately unsustainable—how does one convince donors to fund a project with a 50% success rate? Monitoring and evaluation—and other means of following up with dam communities—are essential to the viability of the sand dam project. Maintaining a consistent line of communication with dam communities through extension workers is one

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<sup>22</sup> Eight of thirty made such claims—about 27%.

very basic way of realizing this imperative, as well as a simple means of maintaining good standing within their target populations. A second important piece of follow-up involves training—clearly four days of intensive instruction has not proven sufficiently effective for the majority of dam communities. Regular follow-up mini-sessions within communities for a defined interval following construction could be invaluable in terms of reinforcing training. Finally, implementing a system of monitoring and evaluation is necessary for improving the performance of the project—it would enable SASOL to identify and address difficulties as they occur, rather than years down the road.

The question boils down to one of capacity: Does SASOL have the capacity to do the necessary post-construction work that, within many communities, can be the difference between having a sand dam and water or having only disappointment? With only a handful of extension agents, the answer seems to be, on the whole, no; however, with sixteen fundis on the payroll, it may be done. *Fundis* might construct two or three, rather than three or four dams per year and spend the remainder of their time doing follow-up training (which would no doubt require a significant investment on the part of SASOL in the continuing education of *fundis*), and fewer new dams would mean more time for extension agents to perform monitoring and evaluation work. It is a possibility that should certainly be considered.

#### **4.0 Conclusion**

The potential of the sand dam paradigm for bringing security and yes, even prosperity, to the communities of Kitui District and beyond seems evident. However, without a stronger commitment on the part of SASOL to constructing *sand dams*, not merely stone and cement barriers, it seems the paradigm will continue along its desultory path, and its wonderful, tantalizing promise will never be fully realized. With any development project it is necessary that affected communities mobilize around and come to own the change that they hope to make in their lives; however, it is one thing to expect ownership after instilling in communities the capacity to succeed prior to and during project implementation, and it is something entirely different to expect that ownership to arise organically over the same span with little effort invested in capacity-building on the part of the funding organization. SASOL seems to have taken the latter course, and the results have been predictably mixed.

SASOL, then, has arrived at a crossroads of sorts. Shall they continue their utilitarian emphasis on quantity over quality, or focus instead on ensuring the success of the dams that they do build, as well as the success of those already constructed that have, as yet, failed to benefit their communities? The team's study of the sand dam paradigm has ultimately led us to arrive at this fundamental question. The answer is not as simple as it may appear—adopting the latter course would require a fundamental shift in the organization's direction, composition, and *modus operandi*, one which is bound to be difficult and whose success is less than assured. We've tried to offer an honest assessment of the situation on the ground, as well as some idea of the direction in which SASOL may proceed toward improved implementation; however, ultimately, the decision for change lies with SASOL. The sand dams paradigm has proven its worth as a means of improving the lives of those living in the semi-arid climes of Kitui District; now SASOL must prove that it can successfully implement the paradigm on a broader scale than has been achieved at the present.



ANNEX D

Terms of Reference, Itinerary,  
Sand Dams Selected and List  
of Persons Interviewed

**September, 2005**

## D.1 Mission Terms of Reference

### 1.0 A Team Approach to Project Assessment

The range of water, agriculture, food, health, environment and socio-economic indicators associated with the set of outcomes and impacts identified will require a team approach to data collection and analysis. Specifically, it is proposed the team shall include:

- 5) Henry Rempel - an economic development specialist who will assess the changes in output levels, income, health and nutrition, food security, and development potential of the communities and households directly associated with sand dam construction and utilization.
- 6) Charity Wanjiru Nyaga - a nutrition and community development specialist to document: nutritional outcomes and impacts of sand dams plus, jointly with Peter Gaff, community organization and co-operative activities; the dynamics that govern mobilizing involvement, establishing and retaining rights of access and use; community approaches to assuring responsibility to maintain, protect and sustain community investments; community methods for resolving conflicts that occur; and the impact of co-operative approaches to water harvesting on household income, food security and overall-well-being. With input from other team members, especially Hilda Kalekye Manzi - she will also document the gender aspects of the sand dam paradigm and assess the gender-related outcomes and impacts associated with the application of this paradigm.
- 7) Hilda Kalekye Manzi - an agriculture specialist to document changes in agricultural practices and output, assess the impact of agricultural changes on the income, food security and overall well-being of the community members. And, jointly with Peter Gaff, assess the environmental impacts of community efforts to develop water harvesting methods as well as complimentary actions for water harvesting, water use, and agricultural development more generally.
- 8) Peter Gaff - will work jointly with the other three team members with a specific focus on the organization and political dynamics of the sand dam paradigm and on the environmental outcomes and impacts of project inputs and outputs

### 2.0 An Assessment of Project Outcomes and Impacts

Project assessment that advances creative, sustainable development plus serves the interests of donors focuses on project impacts and project outcomes. Impact indicators measure the realization of the project's goal(s). Outcome indicators measure the realization of the project's purpose(s).

The sequence of a project applies inputs, which, in turn, generate outputs. These outputs become the basis for project outcomes and, hopefully, project impacts. The input - output stage has occurred, funded by several donors plus Kenyan resources. An obvious output is the existence of approximately 370 sand dams in Kitui District.

**A primary purpose of this assessment mission is to document outcomes and impacts that have and continue to flow from the process of constructing 370 dams.** Systematic data collection will involve Team members applying specific indicators that have been developed for each outcome and impact. The assessment process will be completed with a set of conclusions plus recommendations to shape subsequent extension of the *sand dam paradigm*.

The primary source of data will be on-site inspection, meeting with community leaders and interviews with selected household members who are resident there. An appropriate sampling technique will be employed to enable generalization from selected dam sites to the set of sand dams completed as part of SASOL's Kitui sand dam project.

For each community – set of villages – selected for the field assessment an obvious reference point will be the completion of its sand dam. The data to be collected will obtain a set of current observations and then to ask the respondents to compare this with what was the situation prior to the existence of the sand dam. As some sand dam sites will be more mature than others, a comparison of data from a number of dam sites will also enable the team to document evolutionary changes that are occurring subsequent to the completion of a sand dam.

In addition to this field survey data will be drawn from other relevant sources:

- for each sand dam, community needs and resources as recorded in participatory development sessions during the sand dam planning stage;
- project files from agencies involved in funding the Kitui Sand Dams project: SIDA, MCC/CFGB, DFID, Maji na Ufanisi and World Neighbors;
- separate assessment of capacity and performance of SASOL as a program/project implementing agency;
- interviews with Kenyan and international agencies involved in providing famine relief;
- Kenya agencies at National, Provincial and District levels who share responsibility for water, agriculture, health and the environment in Kitui district;
- local health clinics that serve the immediate health needs of the communities associated with the sand dams that will be assessed.

### 3.0 Selection of Sand Dam Sites for Project Assessment

Consultation with SASOL field staff has generated the following list of streams to be included in the assessment project field visits:

<b>Stream</b>	<b>Number of Sites</b>	<b>Stream</b>	<b>Number of Sites</b>
Kisiio	3	Mbusyani	2
Kyeemukaa	2	Ethi	2
Mwiwe	2	Ithambaka	2
Kyuusi	2	Mavia Matune	2
Kwa Mbai	1	Kithiano	2
Ikindu	2	Muthungwe	1
Kiindu	2	Kalikuvu	1
Nduni	1	Yatta	2
Wii	2	Ngwani	2

This identifies a total of 33 sand dams on 18 different streams. This range of streams will enable observation of communities that can be expected to differ in variables central to the set of outcomes and impacts to be document and analyzed.

- differing degrees of maturity of a sand dam site
- different physical conditions
- different social environments
- different food security (need for famine relief) conditions
- net import/export of food
- changes in household diets
- time spent collecting water
- effect of availability of water on agriculture, sanitation, health and schooling

The precise sand dams on each stream will be selected in consultation with SASOL field staff to meet the overall objectives of the assessment project.

#### 4.0 Projected Mission Outputs

A range of assessment project outputs are projected. At the conclusion of the field survey the team will meet in Nairobi to draw together a preliminary set of conclusions and recommendations. The intent is to provide input for another phase of constructing 600 sand dams to be facilitated by SASOL and Excellent. MCC Kenya and Canadian Food Grains Bank (CFGFB) are proposing to join this new phase by allocating funds for the construction of additional sand dams.

After agreeing on a set of conclusions and recommendations each team member will prepare a report that covers their respective terms of reference (see section 11 below). Where responsibilities overlap, as a team we will decide who will cover specific elements of the terms of reference. When the team members have formally written up their respective findings, Henry Rempel, as team leader, will draw these together into a report on the assessment project. The projected mission report will also include each team member's report as a set of Annexes attached to the main body of the report.

Based on the data collected, Henry Rempel will prepare papers, possibly a monograph, which will tell the story of the *Sand Dam Paradigm*. In addition to information collected during this assessment project these follow-up papers and publications will incorporate further analysis of data collected in the 2002 survey for the *Kitui Sand Dams: Social and Economic Impacts* study. The other three team members will be invited – either together as joint authors or separately – to participate in this venture to publish the findings of our joint analysis.

Ownership of the data collected shall reside with MCC Kenya and SASOL. It is understood that all four assessment team members shall have access to the data for the purposes of submitting requisite reports plus any publications that may flow from this assessment project. In any publications generated the place of SASOL and MCC Kenya shall be appropriately recognized as part of such reports and publications.

## 2.0 Time Frame for Project Assessment

<b>Time frame</b>	<b>Activity</b>
May 1 - 17	Prepare a draft project work plan to serve as a training manual and to guide the team in conducting the socio-economic assessment of SASOL's Kitui sand dam project. The plan defined outcome and impact indicators, outlined an overall strategy to obtain project assessment objectives, defined Terms of Reference for the two Kenyan team members, and allocated responsibilities among the four team members.
June 20 - 21	Travel to Kenya
June 22 - 25	Meetings with MCC Kenya, SASOL and other agencies as required to prepare for project field work
June 27 - 28	Orientation of team members
June 29	Travel to Kitui town
June 30 to Aug 3	Field work in Kitui. The team visited 30 communities, from Monday through Saturday, one sand dam per day. Sunday was a day of rest for the team.
August 8 - 25	Team meetings to arrive at mission conclusions and recommendations plus there will be time for team members to write up their findings in support of such conclusions and recommendations.
August 22 - 25	Henry Rempel meets with MCC Kenya, SASOL and Excellent to define a project that continues implementation of the sand dams paradigm. This included a Logical Framework Analysis with a list of key outputs, outcomes and impacts, appropriate indicators to measure progress for each, plus identification of key risks involved.
August 25 - 26	Travel to Canada
By October 31	A formal report prepared by Henry Rempel documenting the methods, conclusions and recommendations of this assessment project.
September - June 2006	Continue data analysis and write reports, papers, etc. that tell the story of the sand dams paradigm as implemented by SASOL in the Kitui sand dam project (well involve team members if they so desire).

### 3.0 Set of Dams Selected

Table D.3.1: Dams Selected at Random for Socio-economic Assessment

<b>Dam #</b>	<b>Catchment</b>	<b>Dam</b>	<b>Dam #</b>	<b>Donor</b>	<b>Donor Number</b>	<b>Completed</b>
630	Kisiio	K. Mbwika	105	SIDA 1	210	1997
701	Kisiio	Ndunguni A	100	SIDA 1	205	1997
702	Kisiio	Mwetha	104	SIDA 1	209	1997
704	Mwiwe	Ndia Aimu	49	DFID 1719	279	1998
705	Mwiwe	Kyanguni	51	DFID 1719	282	1998
706	Kyeemukaa	Kalikuvu	156	SIDA 2	191	2000
707	Kyeemukaa	Ndivuni	154	SIDA 2 DFID	189	2000
708	Kyuusi	Kakumi	75	DFID 1719	306	2002
709	Kwa Mbai	Silanga	152	SIDA 2	187	2000
711	Mbusyani	K. Muema	231	DFID DFID	84	2000
712	Wii	K. Nzyani	87	DFID 1719	318	1998
713	Wii	K. Mukola	81	DFID 1719	312	1998
714	Kyuusi	Kyamutala	71	DFID 1719	302	2000
715	Ikindu	Kakunike B	64	DFID 1719	295	1997
716	Ikindu	Ikindu 1	68	DFID 1719	299	1999
718	Ithambaka	K. Kathata	232	DFID	67	2002
719	Ithambaka	Mwaniki 2	233	DFID	74	2002
720	Ethi	K. Kathenge	220	DFID	53	2002
721	Ethi	Syokaluvyu B	207	DFID	40	2001
722	Ngwani	Katiliku-1	283	SIDA 3	116	2002
723	Mavia Matune	Kithimani	251	DFID	66	2002
725	Kiindu	K. Ndunda	10	P.N. 1718	242	1997
726	Mavia Matune	Kaukuni	252	DFID	60	2002
727	Kithiano	Kwakilonzo	171	DFID	42	2001
728	Yatta	K. Kasoa 2	353	MCC 20	338	2004
729	Nduni	K. Kitoo	30	P.N. 1718	261	1996
730	Kithiano	Kivauni	175	DFID	8	2002
801	Yatta	Kwa-wambua	345	MCC 20	329	2004
802	Kalikuvu	Kaluvu	153	SIDA 2	188	2002
803	Muthungwe	Muthungue A	186	DFID	19	2001

Table D.3.1: Characteristics of Dams Selected for Assessment

DAM NUMBER	Catchment	Dam	Height Metres	Length Metres	Volume Cub Mt	Construction (person-days)	
						Women	Men
630	Kisiio	K. Mbwika	1.95	20		42	127
701	Kisiio	Ndunguni A	2.5	12		114	245
702	Kisiio	Mwetha	2	20		278	216
704	Mwiwe	Ndia Aimu	1.7	43		612	856
							1,12
705	Mwiwe	Kyanguni	2.1	52		561	3
706	Kyeemukaa	Kalikuvu	1.2	20	37	201	263
707	Kyeemukaa	Ndivuni	1.9	17	27	87	97
708	Kyuusi	Kakumi	2.8	36		174	411
709	Kwa Mbai	Silanga	1.65	24	37	345	300
711	Mbusyani	K. Muema	1.85	36	67	217	214
712	Wii	K. Nzyani	1.95	27		427	362
713	Wii	K. Mukola	2.1	27		66	66
714	Kyuusi	Kyamutala	2.65	28		111	253
715	Ikindu	Kakunike B	2.05	21		329	388
716	Ikindu	Ikindu 1	1.8	25		117	299
718	Ithambaka	K. Kathata	2.5	36	78	636	164
719	Ithambaka	Mwaniki 2	2.5	26	51	113	79
720	Ethi	K. Kathenge	1.3	37	83	539	270
721	Ethi	Syokaluvyu B	2.35	28	45	542	101
722	Ngwani	Katiliku-1	3.75	13	60	872	1080
723	Mavia Matune	Kithimani	1.85	22	45	329	225
725	Kiindu	K. Ndunda	2.3	18		259	161
726	Mavia Matune	Kaukuni	0.3	28	40	580	350
727	Kithiano	Kwakilonzo	3.3	38	67	434	399
728	Yatta	K. Kasoa 2	2.2	29	72	581	408
729	Nduni	K. Kitoo	2.1	15		423	252
730	Kithiano	Kivauni	1.1	20	40	242	187
801	Yatta	Kwa-wambua	1.8	22	52	281	197
802	Kalikuvu	Kaluvu	2.45	37	55	281	214
803	Muthungwe	Muthungue A	2.2	42	70	647	565
Average			2.07	27	54	348	329

#### 4.0 List of Person Interviewed

Gitonga, Jeffrey	Soil Conservation Officer, Central Division, Kitui District Ministry of Agriculture
Matseshe, Phaniel M.	Water Services Trust Fund, Nairobi
Medical Director	Mbitini Clinic, Mbitini
Mukusya, Joshua	Excellent Development
Mulyungi, Josphat M.	Development Coordinator, Catholic Diocese of Kitui
Musiloi, Agustus	Planning and Design, Ministry of Water, Kitui District
Mutiso, Gideon	Managing Director, Muticon Limited, Nairobi and Chairman, Board of Directors, SASOL Foundation, Kitui
Mutiso, Sammy M.	Field Manager and Secretary of the Board of Directors, SASOL Foundation, Kitui
Muveva, Jenalis, Masmeyer, Claudia & van de Craats, Annemieke	Presentation on water quality in selected sand dams constructed with SASOL assistance
Rotich, Mark	Senior Programme Officer, DFID Kenya, Nairobi`
Wambugu, John	Assistant Agriculture Officer - Crops, Central Division, Kitui District Ministry of Agriculture