Community organisation and participatory design of sand-storage dams in Kenya

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Abstract

In Kitui, Kenya, a Non-Governmental Organisation and communities have realised more than 350 sand-storage dams in the last 10 years. The structures store water for livestock, irrigation and domestic use. The EU-funded research project REAL-Rehydrating the Earth in Arid Lands studies possibilities for extending the Kitui approach to other areas, connecting the domains of groundwater storage technologies, water use and community participation. In this contribution community participation in Kitui in relation to decision-making is discussed, based on results from participatory field research within the REAL research project. The results show that activities in the sand-storage dam program have not resulted (yet) in stronger organizational structures on community level. There are but very little communal activities and procedures after dam construction, which can be attributed to the construction process. A probable explanation is that the setting of the context for cooperation is highly predefined by the NGO, in terms of technology applied, short timeframe and training activities.

Introduction

In the Kitui region, Eastern Kenya, more than 350 sand-storage dams have been built in the last 10 years within a set-up in which a local Non-Governmental Organisation (NGO) Sahelian Solutions (SASOL) and local communities co-operate. The small water harvesting structures store sufficient quantities of water for livestock, minor irrigation and domestic use. This type of water retaining structures could be an effective water source, providing a possible answer to the high need for soil and water conservation in the drier areas of sub-Saharan Africa. The EU-funded research project REAL – Rehydrating the Eart in Arid Lands studies possibilities for extending the Kitui approach to other areas. The REAL-project connects the domains of groundwater storage technologies, water use and community participation; it employs activities in the regions of Kitui and Amboseli (Kenya) and Arusha (Tanzania). This contribution focuses on the issue of community participation in the Kitui region, in particular decision-making processes and effects on community organisation. In the next paragraph, the concept of decision making in community participation in general and in water projects in particular is discussed. Then a description of the Kitui situation is presented, taking into account decision-making processes in design and construction of the sand-storage dams. Field research activities into dam design and use processes in the Kitui region are discussed, linking field data to a conceptual discussion below.

Participation as the magic key to solve all worlds' problems seems to pop up in every discussion on development issues. Generally, public (community) participation ranges from involving the public in pre-defined actions of other parties (in practice governmental agencies or NGO's) to the situation, in which the public involves the other parties. Mostert (2003) refers to this last gradation as 'decision-making'; Farrington, Turton & James (1999) define it as 'self-mobilisation'. Van Wijk (2001), who has studied a number of water projects and their relative success on the participation front, combines the two items; final decision-making rests with the community, agency support is provided at the request of the community. Usually, community initiative and control is regarded as the best situation, achieving best results. Testing this hypothesis is less common, in particular on a larger scale. Van Wijk (2001) is one of the exceptions; her study presents the results of a worldwide study under coordination of the Water and Sanitation Program of the World Bank to "test whether participatory approaches that are more demand-responsive and gender- and poverty-sensitive (independent variables) result in water services that are better sustained and used (dependent variables)." (Van Wijk, 2001, p. 5).

Van Wijk (2001) concludes that focusing on a participatory approach taking into account gender and poverty pays off in terms of better functioning water services, although "no five or six 'magic bullets' have emerged. Relationships are numerous and complex." (Van Wijk, 2001, p. 220). Nevertheless, "[b]etter sustained services were especially associated with more demand-responsive project approaches." (Van Wijk, 2001, p. 156). In

demand-responsive projects, the (f)actual decision-making of both women and men community members was stronger than in the others, although in none of the projects women and men household members had taken part in all five planning decisions distinguished by Van Wijk (2001) (which are (1) service initiation; (2) choice of technology and service levels; (3) locations of facilities; (4) local management; and (5) maintenance and financing arrangements). Community involvement in defining technology and service levels was least common (almost 50% of the cases); choosing water committees was most common (almost 80%) (Van Wijk, 2001, p. 173). The methodology employed in the World Bank study, the Methodology for Participatory Assessment (MPA), has been the reference research approach on which fieldwork activities in Kitui within the REAL project have been based.

Introducing Kitui and its sand-storage dams

The Kitui dams are all stone-masonry, sand-storage dams built in non-perennial rivers (figures 1, 2 and 3). The basic principle of such a dam is that water is stored sub-surface instead of in surface reservoirs. Evaporation losses are lower for sub-surface storage; risk of contamination of stored water is reduced, as direct contact is minimized and parasites cannot breed underground. Submergence of land, associated with surface dams, is not present with groundwater dams. A sand-storage dam basically functions as a sub-surface dam, but its crest is raised above bed level. The sand carried by flow during the rainy season will settle in front of the dam; gradually the reservoir will fill up with sand. The sand bed is used to store water from the rainy season. A single flash flood may fully recharge a sand reservoir. Upon full saturation of the reservoir, the remaining flash floods will pass over the dam. The stored volume of a sand-storage dam ranges from 100 m^3 to 50,000 m^3; typical heights range from 1 to 4 meters above the surface. An advantage of sub-surface dams over sand-storage dams is that water does not flow over the dam; no spillway is needed. Thus, a sub-surface dam is not exposed to forces of flowing water, a sand-storage dam is. Giving these extra demands on sand dams, the condition of the dams in Kitui is generally good; in the limited cases in which repair works were needed, downstream erosion was the reason.

Figure 1. Basic layout of a sand-storage dam

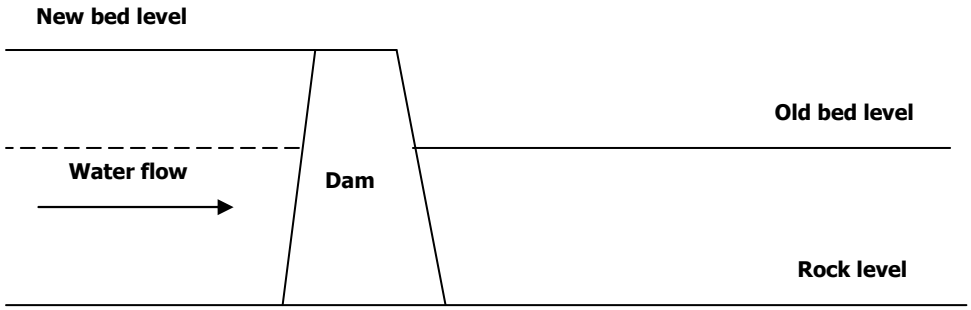


Figure 2. Completed dam in de rainy season (picture from Beimers et al 2001 p78)

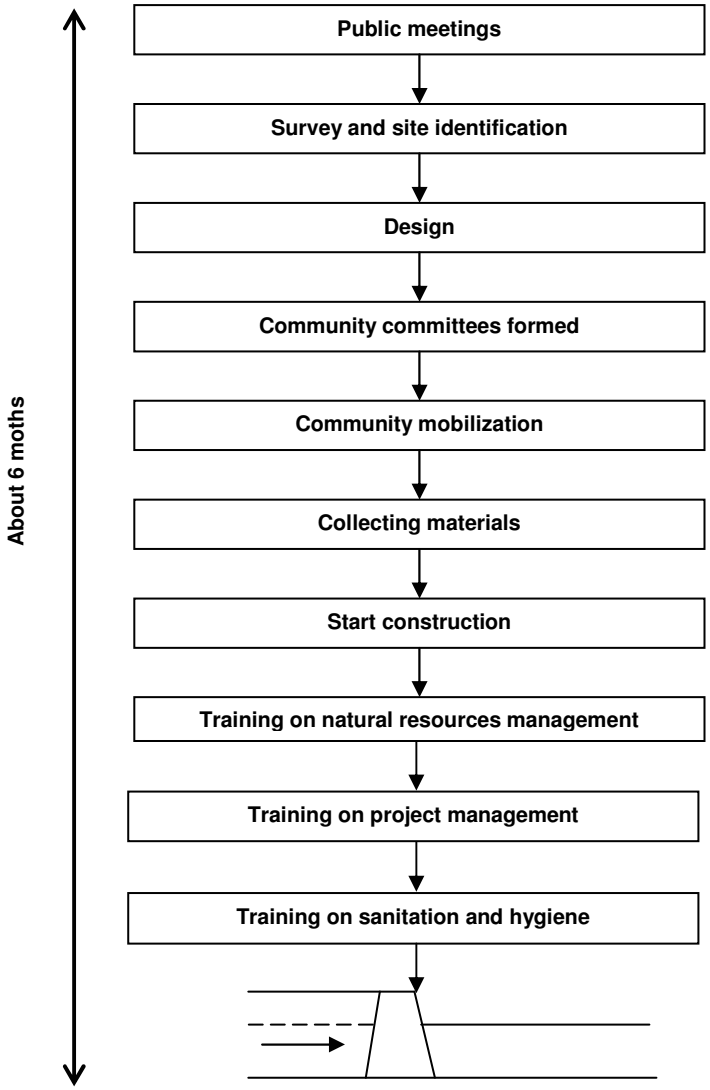
Figure 3. Almost completed dam in the dry season

The complete design and construction process for a sand dam takes about 6 months in Kitui. In practice it starts with a local community requesting SASOL for assistance. In a first meeting (*baraza*), the community defines its problems, sets its priorities and makes decisions on how to solve them (figure 4). "Almost invariably, the shortage of water is the first problem identified, and the action plan therefore addresses ways and means of tackling the problem – not only to increase the quantity and availability of water but also to improve its quality." (Sahelian Solutions & Maji Na Ufanisi, 1999, p. 28). When the decision is taken to continue, the communities have to agree to provide labor for construction of the sand-storage dam. Existing organizational structures such as village development committees are employed when working in a community starts to strengthen them. On the other side it is also encouraged that communities organize themselves in their own way, as village development committees are often weak (SASOL & MNU 1999). In the formation of dam committees, the NGO offers guidelines on the characteristics of the composition of the committee (related to age groups, sexes, education levels, religious beliefs and political party affiliations). A typical sand dam committee has 13 members; the community decides on the composition of the committee.

Another important decision is the location of the dam. Representatives of the community walk with two SASOL representatives (usually the technical manager and a mason) along the river and show them what they think is the best place to build a dam. Before the joint walk the community has already discussed what would be the best location for the dam. The community has picked out the sites taking into account user suitability and knowledge of the area. The dam should be approachable by all community members. A certain dam location could favor farmers who own land closer to the dam than others. As dams generally back up water for a few kilometers, their effect is not as local as one perhaps would expect. Nevertheless, access to and control over the dam itself and the water-enriched banks is a key issue. The presence of a road, which has practical advantages, also appears to be important legally. With a road present, the community does not need permission of the landowners to build the dam. Both women and men are involved in site selection. In the community meetings, women are active participants. Women play a major role as water managers and drawers in the household. As the project is mainly on water, it is logical that they are heavily involved. Women know which areas are most convenient to obtain water from and the distribution of these points for maximum coverage. Another reason for the active involvement of women is the

relatively low number of men in many communities, as men are more likely to migrate to the urban areas of Kenya in search for paid labor. SASOL representatives look from a technical point of view to locations.

Figure 4. Kitui design/construction process



Although design and construction of dams in different sites in the Kitui area shows some variability, as each site is different and the design has to be modified accordingly, all dams have a similar basic design. Topographical, geological and soil conditions of the area influence possibilities for and dimensions of the future dam and underground reservoir. Presence of impervious layers in the subsoil prevents seepage of the water laterally and into the deeper layers. A sandy soil layer with sufficient water retaining capacity and the possibility to build up such a layer is important; the sand provides the storage space within the pores. Sometimes water may be needed at a location with unfavorable conditions. In such cases, risk of technical failure is high. When community and SASOL agree on the location, the technical manager discusses his findings with the SASOL general manager. After the general manager approves the site, the community elects a site committee, which will supervise the implementation, operation and maintenance of the site. Disagreement on locations occurs when community interests are conflicting with required geological conditions. For example, the community members may settle for a site, which is central and thus convenient for most households, a site with fertile flood plains (a necessary condition for agriculture), or a site, which is good for watering animals. On the other hand, SASOL's technical staff may disagree with the site; it may lack the necessary conditions for a strong foundation for the dam. In other cases the community identified sites being too steep to allow the river to deposit sand or having too high velocities.

Field research in the Kitui area

When the location is finally selected, the construction process starts. The community is mobilized to clear the sites, collect locally available construction materials (sand, water and stones). The actual construction starts with digging a trench, which is filled with rocks and mortar with the help of a trained artisan from SASOL. The community provides food and accommodation for the artisan. Besides technical assistance, SASOL provides financial support for buying the most expensive input cement. The community itself has to ensure that all building materials remain reserved for the sand-storage dam. This is successful; only in very few cases the expensive cement 'has walked away'. As a result, water is provided to communities at relatively low cost (SASOL & MNU, 1999). In terms of realisation of physical infrastructure, the sand-storage dam program in Kitui has to be considered a success: more than 350 dams have been built without serious technical failures. In socio-economic terms, a large-scale survey-based study (Muticon, 2002) indicated that the Kitui area shows growing economic activities, like horticulture, brick making and bee-keeping, which are all activities related to water use from sand-storage dams or to time-saving as water is readily available. These economic activities are individual. When it comes to strengthening communal organisation, which was one of the major goals of the sand-dam programme, results appear less favourable. The functioning of the dam committees seems to have ended when construction of the dam has finished; low frequencies of dam committee meetings were found. Many community members seem to be unfamiliar with processes of recruiting dam committee members. Generally, users seem to be uncertain of differences between nomination, election and selection. Indefinite tenure in office was reported too. A related issue is the perceived ownership of dams. A vast majority of the water users in the region, whether they use sand dams or not, perceives water sources as community property. A considerable minority, however, considers SASOL as owner of the sand dams. Apparently, the participatory approach has not resulted in clear ownership.

Muticon (2002) provided a baseline socio-economic study for the REAL-project. Nevertheless, it was decided to do additional fieldwork. One reason was methodological in nature. Muticon (2002) employed a passive large-scale questionnaires approach; the REAL-project uses a participatory research perspective (compare with discussions in Van Wijk (2001)). Another reason was that Muticon (2002) provided much data, but no tested relations between the data. The additional fieldwork within REAL could yield (additional) data, but had to focus mainly on linkages between different issues from the perspective of community members. The REAL-fieldwork was done by four researchers from the University of Nairobi, paired into two groups, who worked under close supervision of senior staff. The IRC International Water and Sanitation Centre provided assistance in preparing the research, which took the MPA approach as guideline (Van Wijk 2001). SASOL participated in the research setup and provided logistic assistance. The study area is located in the central part of Kitui district with a population density of 153 persons per square kilometer. Three communities were selected, which are basically sub-locations; typically a sub-location covers an area of 30 km^2. The definition of a community included aspects such as: sharing a common water source(s), have common community problems and engage in social activities together. Such activities include common welfare associations, funerals, and marriages. In each of these three sub-locations, 11 sand dam committees were selected for the study. Three categories of sand dams were selected for the study: recently constructed, those in the filling stage and mature dams. The data collection period covered 2 months (May and June 2003). Some main results are discussed below (see the annex for details).

Sand-storage dam water is mainly used for uses that do not strictly require safe water. The relatively low use of dam water for drinking is explained by the fact that many dams studied are still in the filling stage and have stagnant water, which is only safe for other purposes. Women and men participated almost equally in the construction process and management of the dams; there was minimal gender disparity in the committees. In cases where dam membership was dominated by one gender, that gender also dominated the committee. Regarding the socio-economic status of the committee members, middle class community members dominate the large majority of the committees. In most committees, the upper class is not represented; in 25% of the cases the lower class is not represented. It is worthwhile to note, that classifications as 'poor' and 'rich' were not easily attached to community members. Generally, the poor were defined as those who are disabled, aged and young children, in other words those people who depend on others. Nobody likes to be classified as rich; if word spreads that one is rich, this may attract thieves. Thus the majority of the respondents preferred to be referred as middle class while at the same time referring to others as middle class. It should be noted that the socio economic classes are based on local indicators. Thus a rich person in one community may be poor or middle class in another one.

Most committees of constructed dams are dormant. In most committees, membership had not changed. If changes occurred, it was because committee members had passed away or had migrated. Most of the committee members

had participated actively in monitoring, control and decision-making during the construction phase. In almost all cases studied, rules were set to guide the community during and after the construction phase. However, most rules covered the construction phase. During construction there was a fair trend in the adherence of rules; cases of non-adherence were checked through the imposition of fines and confiscation of the defaulter's property. Daily monetary contributions during construction period ranged between 5 and 10 Kenya Shilling (1 US $ is about 75 KSh); in other instances people made weekly contributions of about 40 KSh. All contributions were aimed at meeting food and accommodation costs for the artisan and daily food requirements for the participating community members. The secretary of the committee was charged with the responsibility of collecting the money and handing it over to the treasurer. The committee accounted for the expenditure. Even though daily contributions were minimal, some members defaulted. After completion of the construction exercise, monetary contributions ceased. Generally, there were effective management structures during the construction phase of the dams, not after.

In almost half of the cases, there was an aspect of training. The training sessions covered lessons on food budgeting, soil conservation (terracing, tree planting and making compost manure) and sanitation. Most training was conducted by SASOL; some training was done by other organizations (either individually or in partnership with SASOL), mainly by representatives of the ministries of Health, Agriculture or Livestock development. The high percentage of cases without training is explained by various reasons. First, about half of the dams studied were constructed in the 2000-2001 season. This has been a very busy season for SASOL, effectively limiting its ability to let its staff perform training sessions. Second, responses are to be treated with some caution. In general, community members define 'training' as meetings in a seminar or workshop setting. Training sessions using *barazas* (meetings) were not perceived as 'training'. Women participated more in training sessions than men; women are the majority in the rural areas since most men have migrated to urban areas in search of employment. Middle class members dominated the training in terms of numbers. Training activities were organized at the level of sub-location. Each community selected 25 to 50 trainees, both men and women. SASOL left the selection of training participants to the community without guidelines at the beginning. Later some age, gender, literacy and record keeping criteria were given to communities to use when selecting trainees and committees. Most of the trained ended up being dam committee members. Trainees were expected to train other community members, but this has not occurred systematically.

Discussion

The general picture emerging from the REAL-research is similar as the picture from Muticon (2002): activities in the sand-storage dam program have not resulted (yet) in stronger organizational structures on community level, which could stimulate development of other community resources. Although communities are encouraged to organize themselves, in their own way and the community decides on the composition of the committee, this process does not result in clear communal activities and procedures after dam construction. Kitui communities and SASOL cooperate closely during about half a year with the goal to create a sand-storage dam. During these months, knowledge and experience of both actors are shared, for example during the field trip to select the dam-site. After the construction has finished, SASOL does not maintain connections with the community, a factor that could (partly) explain the non-active committees. SASOL does involve the communities in broader issues through training sessions; these trainings appear to be relatively pre-defined. The training sessions are organized "To teach [sic] people on how to make maximum use of the availed water and soil conservation to check dam siltation […]" (Muticon, 2002, p. 125).

Pre-definition of the technical solution, including design and construction planning, may effectively limit community decision-making. As communities approaching SASOL know that water supply through a sand-storage dam will be the outcome of the process, defining main problems may be regarded as a vehicle to create effective links between the community and SASOL. When SASOL started its activities in the early 1990's, its scope included non-water related issues as well. As water provision soon dominated the activities, SASOL decided to focus on it. As a result, other problems defined in the first *baraza* are not a main concern of the process anymore. The Kitui sand dam project is not an exception; as indicated above, participatory planning appears to be least common in the choice of technology and/or service level (Van Wijk, 2001). Perhaps this reflects an accepted and practical division of responsibilities between community and NGO, with a community setting the problems and an agency offering solutions. The sand-storage dam option, however, is the single offer. People's participation is apparently limited to providing physical contributions, within the context of a supply-driven project to construct a pre-defined facility. A standardized package is offered to communities.

Strengthening communities through the standard package of sand dam development would work because the technology is simple and thus suitable for participatory development methodologies (KSD 2002). Indeed, Van Wijk (2001) suggests a relation between the level of 'simplicity' of a technology and the potential for participation in projects employing the technology. A study found that people's participation was strongly associated with the use of simple technologies (Finsterbusch & Van Wicklin, 1989, quoted in Van Wijk (2001)) Apparently, mainly gravity systems (which would be relatively easy to maintain and repair with low recurrent costs) have been employed in projects aiming at organizing communities to manage their own domestic water supply. This mechanism, if existent on a larger scale, cannot be recognised in Kitui. Besides the strict predefinition of the project context, this may also have been aggravated by the fact that the dams need minimum maintenance. Perhaps the relative simplicity and reliability of the technology has even hampered further community involvement. Committees may not want to meet without an issue to be addressed.

Keeping activities limited to just one construction season could have had its negative influence on the possibilities for a community to find a suitable organization, resulting in the problems with dam committees and ownership perceptions mentioned. Organizing takes time; Van Wijk (2001) describes the Swajal project, with a total community project cycle lasting 33 months: 7 months pre-planning, 12 months of planning, and 14 months of construction. Taking more time would coincide nicely with technical arguments to increase construction time, as the literature suggests it is preferred to build a sand-storage dam in three stages of one year each. This allows the reservoir to gradually fill up with coarse sediment, as higher flow velocities will flush fine particles across the dam. The coarse sediments increase potential storage of the dam as they have higher porosities. Furthermore, abstracting water from the reservoir is easier for coarse material. It is a decision made by SASOL to build the dam in a shorter period; SASOL considers it to be difficult to mobilize communities for three consecutive years. Furthermore, a sand dam built in stages will only be fully effective after three years. SASOL claims this time cannot be spared; a solution for the water problems of Kitui was needed immediately. From a technical perspective, SASOL's decision may be defendable, as most dams appear to have no serious problems with the type of sediment behind the dam. From a community development point of view, however, the timing of the efforts could be labeled as less successful, not only for individual dams, but also on a larger scale. With many sand-storage dams constructed in a similar catchment and larger groups of people using that same catchment for different, often competitive uses, it is likely that catchment-level planning and management will become necessary, as SASOL itself acknowledges too (developing such an approach is one of the reasons for SASOL to participate in the REAL-project). Longer planning periods would enhance possibilities to take into account relations between communities in the same catchment, not just of single communities as until now (Farrington et al, 1999; Van Wijk, 2001).

References

Beimers P, Eijk A van, Lam K and Roos B (2001): *Sand-storage dams in arid and semi-arid areas. A manual on location choice, design, construction and maintenance of stone-masonry dams.* MSc-traineeship report, Land and Water Management, Civil Engineering and Geosciences, Delft University of Technology, the Netherlands

Farrington, J, Turton, C and James, AJ (1999): *Participatory watershed development. Challenges for the twenty-first century.* Oxford: Oxford University Press.

Finsterbusch, K and Wicklin, WA, van (1989): Beneficiary participation in development projects: Empirical tests of popular theories. *Economic Development and Cultural Change*, April 1989 v37 i3 p573-593

Muticon (2002): *Kitui Sand Dams. Social and economic impacts.* Nairobi.

Mostert, E (2003): The challenge of public participation. *Water Policy*, May 2003 v5 i2 p179-197

Sahelian Solutions and Maji na Ufanisi (1999): *Where there is no water. A story of community water development and sand dams in Kitui District, Kenya.*

Wijk-Sijbesma, C, van (2001): *The best of two worlds. Methodology for participatory assessment of community water services.* Delft: IRC International Water and Sanitation Center Technical Paper Series 38

Annex

Table 1. Water use of sand-storage dams

Category	*Frequency*	*Percentage*
Watering cattle	36	100.0
Washing clothes	35	97.2
Bathing	35	97.2
Construction	34	94.4
Brick making	33	91.7
Tree nurseries	28	77.8
Irrigation	24	66.7
Drinking	22	61.1
Beer brewing	21	58.3
Bee keeping	18	50.0
Fish breeding	16	44.4
Swimming	13	36.1

Table 2. Dam committee meetings

Category	*Men*		*Women*	
	Frequency	Percentage	Frequency	Percentage
Never held	0	0	0	0
Occasionally	0	0	0	0
Regularly, key members attend	5	13.9	3	8.3
Frequently, most attend	13	36.1	13	36.1
Frequently, all attend	18	50.0	17	47.2
Missing cases	-	-	3	8.3
Total	36	100	36	100

Table 3. Rules set in the dam construction process

Category	*Men*		*Women*	
	Frequency	Percentage	Frequency	Percentage
No Rules	1	2.8	1	2.8
Rules established, not followed	6	16.7	5	13.9
Rules established, few followed	12	33.3	10	27.8
Rules established, most followed	4	11.1	4	11.1
Rules established, all followed	13	36.1	13	36.1
Missing cases	-	-	3	3
Total	36	100	36	100

Table 4. Training in the sand-storage dam project

Category	*Frequency*	*Percentage*
None	20	55.6
Natural resource management	2	5.6
Community leadership	3	8.3
Sand dam maintenance	2	5.6
Mixed NRM/CL/SDM	7	19.4
Other (food security, horticulture)	2	5.6
Total	36	100%

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