

*Full Length Research Paper*

# Reducing poverty and food insecurity by applying in-field rainwater harvesting (IRWH): How rural institutions made a difference

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Various studies have been carried out to address the problems of rural poverty and agricultural development with mixed outcomes. While some of the proposed measures for increasing agricultural productivity and poverty alleviation have yielded some promising results, there is growing consensus on the need for a comprehensive approach which also looks at the institutional and socio-cultural environment as determinants of rural farm/households' livelihood. The paper aims at exploring the role of rural institutions in the adoption and sustainability of productivity-enhancing technologies among small-scale farmers using Thaba Nchu in the Free State, South Africa, as a case study. The paper attempts to explain an observed widespread adoption by small-scale farmers in Thaba Nchu in the Free State Province, of in-field rainwater harvesting (IRWH) techniques that was recently introduced in the area. This was achieved by using data from the experiences and observations of a multidisciplinary team consisting of agronomists, agricultural economists and sociologists from the University of the Free State (UFS) and Agricultural Research Council (ARC) and farmers from the area. The paper concludes that the participation of local farmers, particularly through local community groups, played important roles in achieving a more widespread adoption of IRWH techniques. This suggests that both formal and informal rural institutions can play important roles in ensuring acceptance of new production practices by small-scale farmers and these institutions should be included in the design of an effective agricultural extension program. Furthermore, institutional reform should be considered in policy interventions that promote poverty and food insecurity reduction.

**Key words:** Productivity-enhancing, Thaba Nchu, multidisciplinary, agronomists, socio-cultural.

## INTRODUCTION

Sub-Saharan Africa has an estimated 41% of its present agricultural land located in semi-arid regions, with only a small proportion under some form of irrigation. This implies that rain fed agriculture will be an important source of food for an increasing population in semi-arid and arid areas of the world (FAO, 1990; Parr et al., 1990). In South Africa, most of the small-scale and subsistence (communal) farmers are found in areas that are marginal for crop production as they are semi-arid to arid with only a small proportion of the land under some form of irrigation. In addition, small-scale and subsistence

agricultural productivity in South Africa is regarded as being very low while it has to support most of the rural poor since the majority of the poor (72%) lives in these areas and rely mostly on rainfed agriculture (Ortmann and Machethe, 2003; National Department of Agriculture (NDA), 1998, 2001). As a result, most of the rural population are living in poverty and are affected by food insecurity. Therefore, there is need for a more efficient use of water and land in both rainfed and irrigated agriculture to meet future food demand and growing competition for productive resources (Fox and Rockstrom, 2003).

Sustained growth in agricultural productivity is seen as critical to improvement in food security (Ortmann and Machethe, 2003; Weibe, 2001) for rural populations, as it translates into increased food supplies and lower prices

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for consumers. Secondly, growth in agricultural productivity means higher incomes. This means an improved ability to purchase food and other basic necessities, for many food-insecure households who earn their livelihoods through agricultural production.

In an effort to increase small scale agricultural productivity through the efficient use of land and water in rural semi-arid areas of South Africa, the Agricultural Research Council (ARC) developed a new production technique that incorporate water conservation (Botha et al., 2001) called in-field rainwater harvesting (IRWH) technique. The technique combines the advantages of water harvesting, no till, basin tillage and mulching on high drought risk clay soils and reduces total runoff to zero and evaporation from the surface considerably (Botha et al., 2001). In addition IRWH has been shown to increase farmers' income and reduce risk significantly (Kundhlande et al., 2004). It has been proven that the technique will be suitable for application in semi-arid areas of South Africa (Baiphethi et al., 2004; Kundhlande et al., 2004; Botha et al., 2004) and contribute to household food security and poverty alleviation.

A lot of work has been done to address the problems of rural poverty and agricultural development with mixed outcomes. While some of the proposed measures for increasing agricultural productivity and poverty alleviation have yielded some promising results, there is growing consensus on the need for a comprehensive approach which also looks at the institutional and socio-cultural environment as determinants of rural farm/households' livelihood. The new approaches place a lot of attention on local participation, supporting the construction of social capital and linking the poor to the dynamic sectors of the economy. Some scholars argue that most of the past efforts at alleviation of rural poverty and improvement on agriculture, focused mainly on investments, credit and policies. However, the lack of efficient institutions and organizations minimized the impact of the investments and policies. It is further argued that the absence of effective organizations and institutions explains the low return rate in agricultural investments in Africa and thus the poor performance of the sector. While several types of institutions are deemed important for poverty alleviation efforts, community level institutions are emphasized in rural development efforts. Community level institutions allow local participation that in turn allows the small-scale resource poor farmers a voice and through a transfer of responsibility gives them the power to discover and determine their lives (farming systems).

This paper aims to explore the role of rural institutions in the adoption and sustainability of productivity-enhancing technologies among small-scale farmers using Thaba Nchu as a case study. The paper attempts to explain an observed widespread adoption by small-scale farmers in Thaba Nchu in the Free State Province, of in-field rainwater harvesting (IRWH) techniques that were recently introduced in the area.

## MATERIALS AND METHODS

### Description of study area

Thaba Nchu is located 58 km east of Bloemfontein and was formerly part of the Bophuthatswana homeland (Kundhlande et al., 2004; Baiphethi et al., 2003). A large population lives in 42 villages around the town of Thaba Nchu. Low rainfall and high evaporation coupled with poor soils are the major constraints to crop production.

The area has limited employment opportunities outside agriculture (Free State Province/World Bank, 1997). Like other rural areas, poverty and food insecurity are the major problems facing households in the study area. Currently, land is one of the readily available productive assets for most households. Each household has access to about 2 to 4 ha of arable land. In addition households have 0.2-ha-residential land, a portion of which can be used as homestead garden on which a household can produce crops such as maize and vegetables. Most of the arable land remains unused in part due to lack of appropriate production technologies, low returns from production and other constraints (e.g., high input costs, low and erratic rainfall, poor market access, etc.). To alleviate the problems of food insecurity and unemployment, the available land needs to be put into efficient production so as to increase the food supply for the farm households and also generate additional income.

### Data

The data used in the paper were collected from Thaba Nchu, over a period of four production seasons. The production seasons were 2001/2002 (inception), 2002/2003, 2003/2004 and 2004/2005. This data collected was aimed at tracing the adoption trends in the whole area as well as in some chosen villages. Mainly, the data comprises the number of households (homestead gardens) that adopted the technique, the number of villages in the area that took up the technique and how long each village has been using/exposed to IRWH. This data was used to explain or shed light on why in general the technique was widely accepted in the study area and also explain the differences or similarities in adoption trends for some selected villages. Comparisons were made between villages where there are varying degrees of adoption, efforts were made to justify and/or understand the discrepancies.

### Analytical framework

The current study is rooted in the Farming Systems Research and Extension (FSRE) Approach, wherein the researchers first seek to understand the farming systems within which the envisaged benefactors of the research and extension efforts operate. FSRE emphasizes a careful understanding of the conditions under which the farmers operate such that it can facilitate the development, dissemination and evaluation of technology that is best suited to the farmers' needs (Kundhlande et al., 2004; Tripp et al., 1990). By its nature, farming systems approach is system-orientated, location specific and thus interdisciplinary. Most importantly, the approach recognizes the central role of farmers in any technology development initiatives, in that it emphasizes the testing and assessment of new technologies on farmers' fields, under their conditions and using their criteria. This requires that there be effective interactions between farmers and researchers to guide the process of technical change along a socially optimal path (Kundhlande et al., 2004). These interactions can be enhanced if farmers are organized into associations such that they can apply pressure on research and extension services, as well as improve the success of the technology exchange processes.

In order to undertake this task, a multidisciplinary team of researchers was assembled at the inception of the project. This team comprised agronomists, soil scientists, agricultural economists and sociologists from the University of the Free State (UFS) and Agricultural Research Council -Institute for Soil, Climate and Water (ARC-ISCW, Glen). The team identified several sites in the study area with the help of the agricultural extension offices in Thaba Nchu, which helped to categorize the villages in the area and thus enabled the research team to select the representative villages that will work with the multidisciplinary team of experts. After the selection and identification of the representative villages, the team visited the villages in order to identify the major constraints to agricultural production. This was done using participatory rural appraisal (PRA) techniques wherein the researchers and farmers together, identified the major constraints and the possible solutions to such constraints.

It became evident from these participatory interactions that farmers were heavily constrained by erratic rainfall, lack of resources (production inputs), low returns from production, high risk (crop failure) associated with their traditional (conventional) production practices. In addition, the farmers and the researchers identified a lack of appropriate alternative production technologies. This has led to the abandonment of crop production by most farmers (Baiphethi et al., 2003). Nonetheless, the communities that the team interacted with indicated that food insecurity and lack of employment opportunities could be partly ameliorated by improving agricultural production. This provided a potential means for more secure livelihoods for communities in the study area. It was then that the research team introduced the possible application of the IRWH technique. However, being a new technology, there was need to set up demonstration plots for the technique in selected farmers' fields or backyard gardens.

## EMPIRICAL RESULTS

### The emergence of village farmers groups

In recognition of the large labour outlay needed to construct the IRWH system, the participating farmers organized themselves into groups that would manage the demonstration plots and also help the members receive similar training about the IRWH technique. These groups performed all the activities on the demonstration plots with the guidance of the relevant research team members. The activities included mostly the cultural practices required. These groups were also to take a pivotal role in the transfer of the technology to the rest of the community should the demonstration plots succeed. Within the first season of demonstration, some of these groups had already increased their membership and thus adopted as a model for transferring the technique to the rest of the community. The groups were responsible for selling the technique to the rest of the community and also in helping new entrants in setting up and maintaining the system. These groups were largely informal as they did not have any formal rules and regulations and operated mostly on consensus among the members. While there were no written rules and regulations, the groups had agreed upon requirements and expectations among its members.

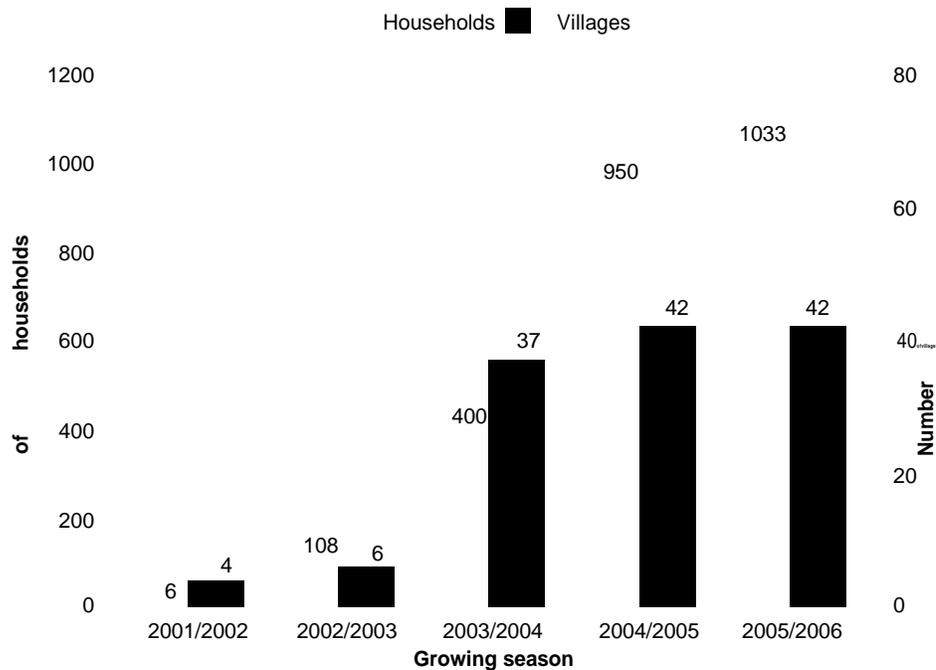
By the second season of the introduction of the IRWH technique and the village groups, some communities had

almost formalized these village groups and also written down some rules and regulations that members had to abide by. The village groups also started the allocation of names and mottos to indicate the purpose of their existence. An example being in Yoxford where the group was named 'Mahata-mmogo' (literally meaning stepping together), to indicate that the farmers were united in purpose and would want to progress together. More villages also followed this example, which became a model for adoption of the IRWH technique. As the groups grew, they were then dubbed community based water harvesting interest groups (CB: WHIGs). The groups were seen to be instrumental in the transfer of the IRWH technique among community members. However, their success varied from community to community.

### Adoption of the IRWH technique by villages in the study area

The results of the adoption of IRWH technique by villages in Thaba Nchu are presented in Figure 1. In the first growing season (2001/2002), six households in four villages applied the technique. As earlier stated, these were also to serve as demonstration plots and the households on which the plot was made were to work with other villages in a group for the maintenance of the demonstration plot. In the following growing season (2002/2003), the use of the technique had expanded to six villages and the households using the technique had increased to 108. The greatest expansion during this period was in Yoxford where the farmers group had consolidated itself, and also during the farmers' festival wherein other villages were invited to participate. In this festival, the technique was explained to the participants and most of them took up the technique thereafter. By the 2003/2004 growing period, the technique had been taken up by 37 villages of the total 42 villages around Thaba Nchu. As stated, each village initially formed a group of interested households and then the team would help the said village in establishing the system in their backyards. This was done by helping the farmer group construct at least one system in a homestead garden and the village group helped the rest of the households. Within another production season, all the villages had adopted the technique. During the 2005/2006, there are 1033 households using the technique in Thaba Nchu.

The results show that there was widespread adoption of the IRWH technique by farmers in the area. This is mostly attributed to the success (varying degrees) of the village water harvesting interest groups. Of importance in the success of these groups was the kind of leadership that drove the different groups. In some villages there was already a strong culture of collective action and this made easier to mobilize the community. An example being in Yoxford where there was already in existence a youth group, which was instrumental in making the water harvesting interest group take off the ground.



**Figure 1.** A graphical representation of the expansion of *IRWH* in different rural villages among households during the 2001/2002, 2002/2003 and 2003/2004 growing seasons.

### Adoption of *IRWH* technique within selected villages in Thaba Nchu

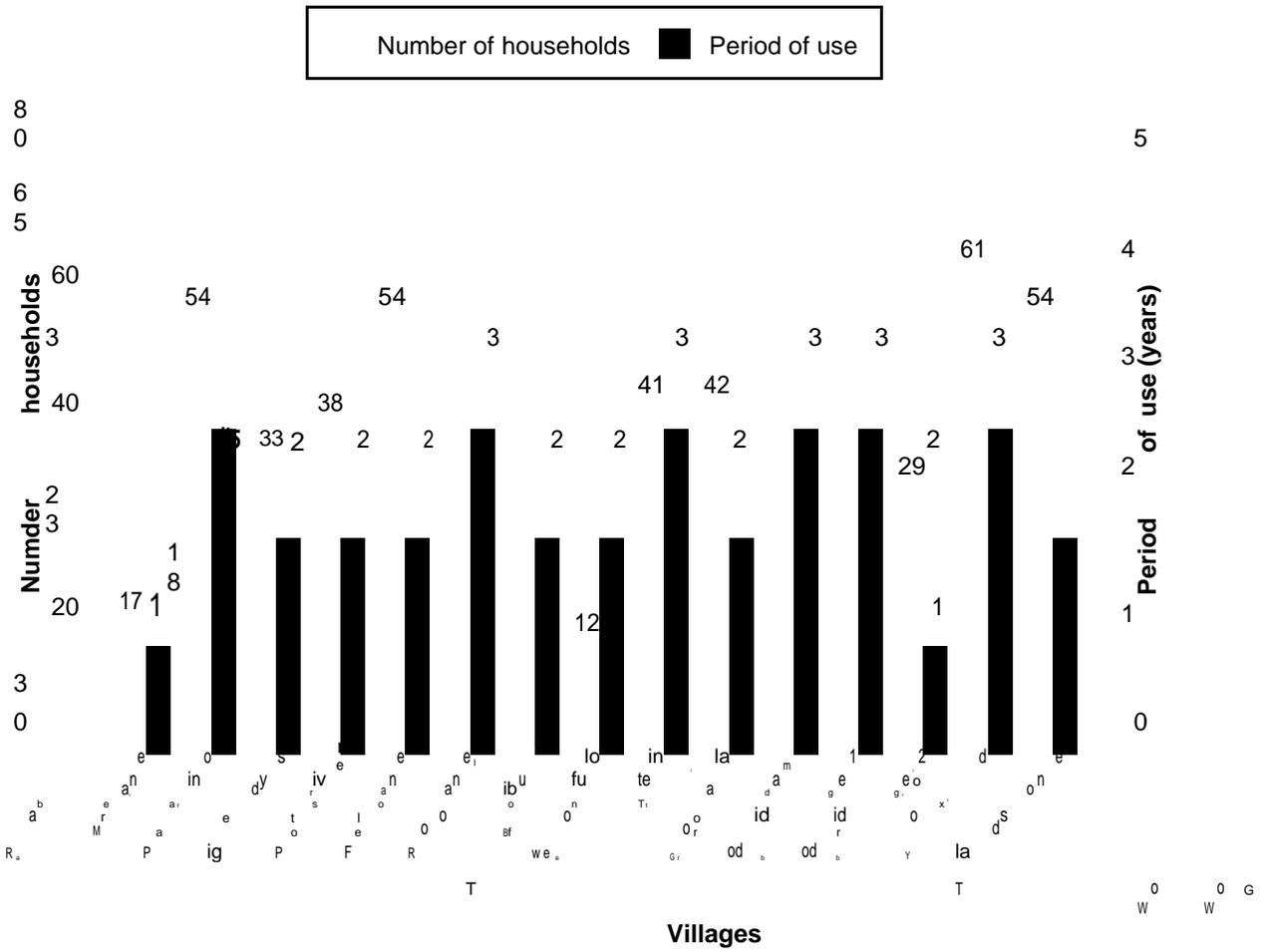
Figure 1 shows that there is a general widespread adoption of the *IRWH* technique in the Thaba Nchu villages, though there were differences in the rate of adoption from village to village. Comparing the period that each village was exposed to *IRWH* and how many households in that village took up the technique enables one to capture the differential rate of adoption in the villages. The results of the period of exposure to *IRWH* and number of households adopting the technique are presented in Figure 2.

From Figure 2, some villages took longer time than others in having a widespread adoption of the *IRWH* technique. The period of exposure varies from one to three growing seasons and the number of households taking up the technique over that period ranges from 3 to 65 households. The villages that adopted the technique are categorized into those in their third season (longest exposure), second season (medium exposure) and first season (shortest exposure). Among the villages that fall in the longest exposure to *IRWH* technique, Yoxford recorded the largest number of adopting households, followed by Tweefontein while Grootdam recorded the lowest number of adopting households. Feloane and Woodbridge 1 seem not to be falling between. But a closer look at the trend shows that Feloane is just stagnant as the numbers neither increases nor decreases. The success of Tweefontein and Yoxford, seem to be

explained by the effective leadership that the two villages enjoy and thus fully functioning water harvesting interest group. There seem to be fewer disputes and the two villages have developed the rules and regulations that govern the group. However, though these two had high adoption numbers, their numbers seem to be no longer increasing significantly. In Grootdam, while there are few adopters there is little evidence of cooperation among those few adopters. This might explain the reason for non-expansion of the technique in the village.

Like the longest exposure category, there are also varying degrees of adoption among the medium exposure group (2 seasons). While some villages recorded very high levels of adoption, others recorded very little though there was a general trend of increase. The number of adopters in this category ranges from 12 to 65. The highest adopters were again within those villages where there is effective leadership and functioning water harvesting interest group e.g. Rooibult and Gladstone. In these two cases, the groups had a very strong leadership. This helped the group to be more cooperative and thus be able to advance *IRWH* in the community. In the final group (only one season), Woodbridge 2 recorded the highest number of adopters and the other village followed closely.

In general, it was observed that there were more adopters in the initial phases of exposure (first and second), but the rate dropped over later seasons. However, the rate of adoption also depends a lot on the type and caliber of leadership that a village group has.



**Figure 2.** A graphical representation of the expansion of IRWH in different villages in Thaba Nchu and the period of use of the IRWH technique.

This is to be expected since any technology adoption process will ultimately get to its threshold level. However, it is an important lesson for IRWH transfer activities, as it points to the fact that it will take at least three seasons for one to really measure how effective the effort has been. Also, the results underline the importance of community groups in technology transfer activities.

### Conclusions and Recommendations

The paper has demonstrated that community participation in technology development, dissemination and evaluation is important. Furthermore, for meaningful agricultural research and extension efforts, the farming systems of the envisaged benefactors need to be understood by interacting with the communities in order to identify and possibly solve the problems. Secondly, the paper has also shown that there was a widespread adoption of IRWH technique by communities and farmers

in Thaba Nchu. Since IRWH has had considerably success in the area, it will contribute to increased agricultural productivity and hence help in the alleviation of poverty and food insecurity. Furthermore, the technique is currently being practiced mostly in backyard/homestead gardens but has the potential to be expanded to crop fields. This will make a bigger contribution to poverty alleviation as well as employment creation.

The adoption of the technique as shown by the results varied from village to village. The villages, which had a higher adoption rate, were characterized by a relatively high degree of cooperation among community members and strong leadership in the village water harvesting interest group. The leadership played an important role in transferring the technology to community members. In addition, it was observed that during the first and second season of exposure, more households adopted the technique and stabilizes thereafter.

According to the findings of this paper, it is recommended that community participation be included into development initiatives, especially where new technologies will be transferred to the communities. Secondly, this community participation should be consolidated into organized structures (formal and informal) that will play active roles on behalf of their respective communities. This suggests that both formal and informal rural institutions can play important roles in ensuring acceptance of new production practices by small-scale farmers and these institutions should be included in the design of an effective agricultural extension program. Furthermore, institutional reform should be considered in policy interventions that promote poverty and food insecurity

reduction. The model used in the transfer of IRWH technique to the communities is recommended for use in other related efforts with adjustments to meet the location conditions.

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### REFERENCES

- Baiphethi MN, Kundhlande G, Viljoen MF, Botha, JJ, Van Rensburg LD (2003). A preliminary analysis of the economic viability of water conservation systems in semi-arid areas in South Africa: A case study of Thaba Nchu in the Free Province. In: Beukes D, de Villiers M, Mkhize S, Sally H, (eds). Proceedings of the Symposium and Workshop on Water Conservation Technologies (WCT) for Sustainable Dryland Agriculture in sub-Saharan Africa, 8-11 April, Bloemfontein. Agric. Res. Council (ARC)-Institute for Soil, Climate and Water, Pretoria, S. Africa.
- Baiphethi MN, Viljoen MF, Kundhlande G, Botha JJ, Van Rensburg LD (2004). Quantifying the impact of in-field rainwater harvesting (IRWH) production techniques on household food security for communal farmers in Thaba Nchu, Free State Province. Paper presented at Agricultural Economic Association S. Africa Annual Conference, Cape Town, S. Africa
- Food and Agriculture Organization (FAO) (1990). An International Action Programme on Water and Sustainable Agricultural Development. FAO, Rome.
- Fox P, Rockstrom J (2003). Supplemental Irrigation for a dry spell mitigation of rainfed agriculture in the Sahel. *Agric. Water Manage.* 61: 29-50.
- Free State Province (FSP)/ World Bank (1997). Free State Mission on Rural Investment: Action Program for the Creation of Sustainable Livelihoods in the Rural and Peri-Urban Economy of the Free State: 1996-1997, Department of Agriculture, Rural Strategy Unit, Glen-Free State Province, South Africa.
- Kundhlande G, Groenewald DG, Baiphethi MN, Viljoen MF, Botha JJ, Van Rensburg LD, Anderson JJ (2004). Socio-economic impact study of water conservation techniques in semi-arid areas. Water Res. Commission, Pretoria.
- National Department of Agriculture (NDA) (1998).

- Agricultural Policy in South Africa: A Discussion Document, Min. Agric. Land Affairs, Pretoria.
- National Department of Agriculture (NDA) (2001). The Strategic Plan for South African Agriculture. National Dept. Agric. Pretoria, S. Africa.
- Ortman G, Machethe C (2003). Problems and Opportunities in South African Agriculture. In: Niewoudt, L and Groenewald, J. (eds.), 2003. The Challenge of Change: Agriculture, Land and the South African Economy, University of Natal Press, Pietermaritzburg, S. Africa.
- Parr JF, Stewart BA, Hornick SB, Singh RP (1990). Improving the sustainability of dryland farming systems: a global perspective. In: Singh RP, Parr JF, Stewart BA (Eds), Adv. Soil Sci. Dryland Agric. Strategies Sustain. 13: 1-8.