Chapter

Adoption of Conservation Agriculture as a Disaster Risk Reduction Tool in Chivi District, Zimbabwe

Jestina Chineka, Nthaduleni Samuel Nethengwe and Hector Chikoore

Abstract

Drought tops the list of disasters affecting southern Africa. In Zimbabwe droughts recur, leaving approximately three million people food insecure. Hence the adoption of sustainable adaptation strategies to drought becomes imperative. Conservation Agriculture (CA), has been successfully adopted in southern Africa to avert drought shocks among other agricultural challenges. Despite the success of CA in some regions, its effectiveness in semi-arid parts of Zimbabwe has been widely contested. However the effectiveness of a new technology, in the face of disasters depends on its adoption, reflecting its strength and usefulness. This chapter seeks to evaluate the adoption of CA in the semi-arid Chivi District of Zimbabwe and unpack factors affecting CA adoption to provide baseline data to policy makers in Zimbabwe and other similar environments. The chapter is based on data elicited from a survey held across Chivi District in Zimbabwe.

Keywords: adaptation, adoption, conservation agriculture, disaster risk, drought

1. Introduction

Climatic disasters such as drought have become a concern in Africa. Agriculture productivity in southern Africa is declining due to these disasters [1]. Zimbabwe is not an exceptional, [2] note that agricultural yields in Zimbabwe are averaging less a tonne per hectare, resulting in protracted food insecurities despite farmers having large pieces of land. Drought effects are felt in most parts of Zimbabwe where rainfall patterns have become erratic [3]. Hence communities are in dire need of effective, long-term strategies to cope. With recurrent droughts and current climate change projections, the future of food security is not only hinged on productivity and availability of food reserves but on addressing the challenges posed by climatic risks such as drought. Resilience of agricultural technologies is critical in communities where agriculture is the backbone such as in rural Zimbabwe.

CA is one humanitarian initiative introduced in Chivi District, to curb the effects of drought and ensure food security. CA is an agricultural system which seeks to conserve water and soil through its main principles of zero to minimal tillage, crop rotation and mulching. CA has been hailed globally for its ability to

increase agricultural productivity under diverse climatic conditions. The same CA project in Chivi, was implemented in Zambia and increased crop yields by 240 to 400% [4]. In Kenya, Ghana and Malawi agricultural profitability increased [5–7]. Despite all this success CA project in Chivi has been characterized by conflict and contestations and its adoption has been very slow [8, 9]. It is within this breadth that this chapter seeks to assess CA adoption in Chivi and establish the weaker lines within the CA project.

IPCC's climate change projections predicting an increase in temperatures and acute rainfall shortages in southern Africa of between 1.5°C to 2.5°C under the 2.0°C GWL and 10 to 20% reduction in precipitation, it is crucial to draw sustainable adaptation strategies and improve resilience in rural communities, which are more vulnerable [10]. This research also unveils factors affecting the adoption of CA and enhance its effectiveness as an adaptation strategy to drought.

The effectiveness of a new technology depends on its adoption and also the project's adoption levels reflect on its strength thus convenience and usefulness in the user's interpersonal networks [11]. Adoption is defined "as the extent to which farmers put into practice a new innovation, given adequate information about the technology and the potential benefits" [12]. The Tradeoffs model inform that farmers are rational beings and only adopt a new system of agriculture if it's more viable [13]. This chapter sought to evaluate the adoption of CA in Chivi.

2. Methodology

The data used in this chapter was elicited from 140 household questionnaires administered across 16 wards of Chivi District and focus group discussions held in six wards of Chivi district. This data was also supported by data from key informant interviews held with three Non-Governmental Organisations (NGOs) and 16 Agricultural Research and Extension (AREX) officials.

Data capturing was organized in Microsoft Excel 2013 and later transferred to Stastical Package for Social Science (SPSS). Prior to the analysis, captured data was coded according to the levels of measurement. This allowed for uni- and bivariate data analyses. Data analysis was done using SPSS version 22. Chi square and Cramer's V value were calculated and analysis was set at 0.05 confidence level. In order to describe and identify relationships that must be taken into account and characterise CA project in Chivi District, frequency tables and bar graphs were generated (univariate analysis). Frequency distributions described the number of times the different attributes of a variable were observed in a sample. This allowed for the comparison of different variables. Statistical tests of significance were conducted on the levels of awareness and general perceptions in order to explore independent variables e.g. gender; age; level of education differences. Chi-square tests was used to calculate significant differences in different demographic groups on their adoption and practices in the Conservation Agriculture project [14]. A 95% level of significance was used, which is most commonly used in social research [15].

Cramer's V test was used to measure the strength of relationships. It measures the strength of relationship for any size of contingency table, and it offers good norming values from zero to one (0–1) for relative comparison of the strength of correlation regardless of the table size. For Cramer's V, 0.0 to 0.30, the strength is considered no relationship to weak; for Cramer's V, 0.31 to 0.70, the strength is considered moderate relationship; while for Cramer's V from 0.71 to 1.0, the strength of the relationship is considered strong [16].

For qualitative data analysis, Archive of Technology, Life world and Language. Text interpretation (Atlas.ti 8) was used to analyse data from the household

questionnaires, focus group discussions and key informant interviews. Tools such as Co oc was used for comparisons using the occurrence frequency, Co-code Doc Table for numeric analysis as well as Networks and Report tool for visual and text analysis. Results from Atlas.ti 8 were used to compliment data from SPSS. Results were presented as graphs, charts, visuals and narratives.

3. Results and discussion

3.1 CA adoption in Chivi

The physical adoption of the CA project was measured based on project adoption records of NGOs operating in Chivi district.

Only 30% of households in Chivi are practicing CA, refer to **Figure 1**. AREX officials and Focus Group Discussants showed that CA started as early as 1995 in some wards such as Ward 10 but became more popular from 2008 when the government of Zimbabwe formalized it. This implies that the project has been long operating in the District, despite low adoption percentage. However, CA benefits are normally realized at least after 10 years of practice [17]. Hence a 30% adoption is not that low, considering that the project is formally slightly over a decade in most wards. After seeing the benefits more farmers are likely to adopt CA. However data on CA adoption trends did not support this. Key informants confirmed a decline in adoption trend over the years in all wards. In ward 21 of the 300 farmers who initially adopted CA in 2008 only 80 are currently practicing it. Of interest is that Ward 21 was listed as the third highest adopter of CA in the District by NGOs. This gives a gloomy picture to the sustainability of CA as a drought risk reduction tool in the District.

3.2 Extension of CA plots

To get an insight into the spatial adoption of CA and the long term plans of farmers on CA, plot sizes were also assessed. Key informants showed that farmers under the main NGO, CARE increased their demo plots from the 18 mother demo plots of 1 hectare to 180 baby demo plots across its 12 wards. However the questionnaire survey showed that 100% of CA farmers are still working on demonstration plots in groups and have not adopted the full CA package onto their individual

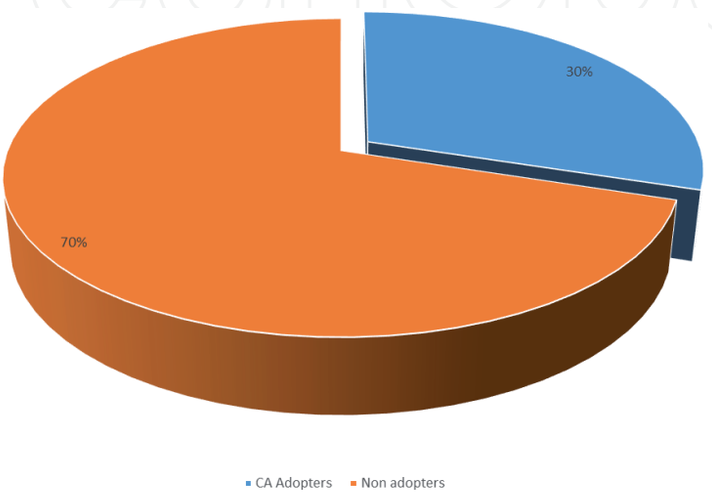

Figure 1.
CA adoption in Chivi.

plots. However 100% admitted to have adopted at least one of the CA principles and are using them in their conventional agriculture system. 52% of these farmers adopted planting on time, 80% crop rotation and 38% use of small grains. No CA farmers have adopted planting basins and mulching onto their traditional systems. NGOs supported these findings and added that planting basins and mulching principles are the most unpopular. These two principles could be the hindrance to effective adoption of CA as a disaster risk reduction tool in Chivi.

3.3 Social buy-in into CA

The social acceptance of the CA project was assessed to get the level of social acceptance of the project. Social discourse and verbatim around the CA project was used as indicators. 72% of participating groups under Focus group discussions described their role in CA as beneficiaries, refer to **Figure 2** below and very few had an active verbatim concerning their role under CA.

Verbatim assessment by Wards showed that only 28% of participant Wards had a positive view about their role in CA. Ward 21 and 24 showed an active role in CA (**Figure 3**). Ward 10 besides it being the first ward to be introduced to CA in 1995, over two decades ago it showed a passive role in CA project.

Focus group participants of about 72% admitted to being passive beneficiaries of CA and had no active or decisive role in the project. The community described NGOs as the "owners" of the project while AREX officials were described as "trainers". Throughout the whole cycle from its formulation to implementation community members are passive participants. On the discussion surrounding difference between CA and the conventional farming, 77% of participants showed that there is no difference in terms of benefits, this contradicted the views of NGOs and AREX officials, whom most of them pointed out the difference in yields per hectare in which CA has better yields. Social discourse on CA project was characterised by undertones of disassociation and negativity. The community coined the main principle of CA, zero tillage "Dhiga ufe" meaning dig and die, alluding to its labour intensive nature. Commenting on CA benefits the focus group participants who did not adopt the initiative said,

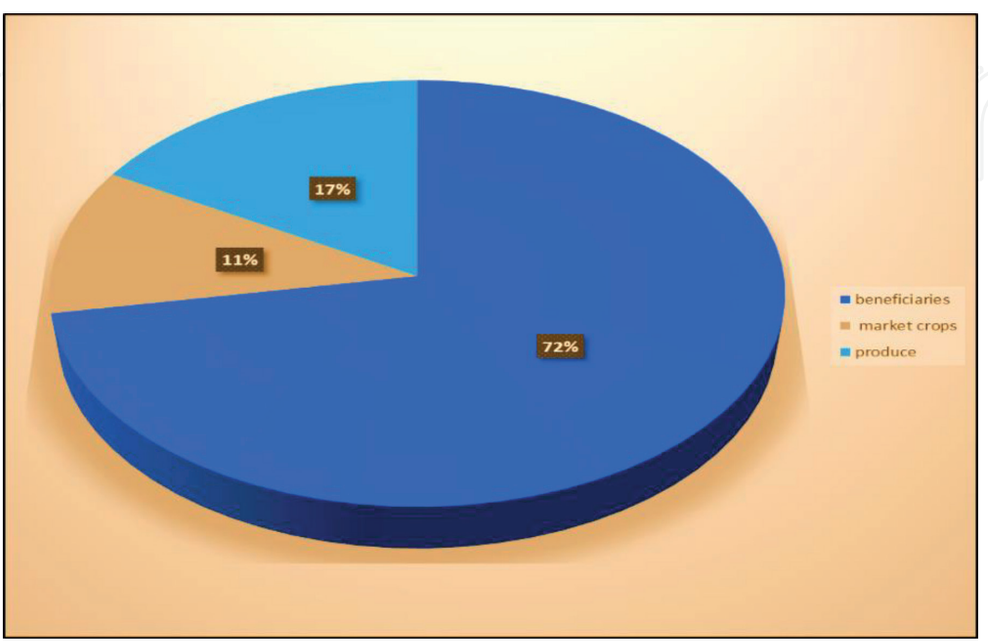

Figure 2.
Role of Chivi community in CA.

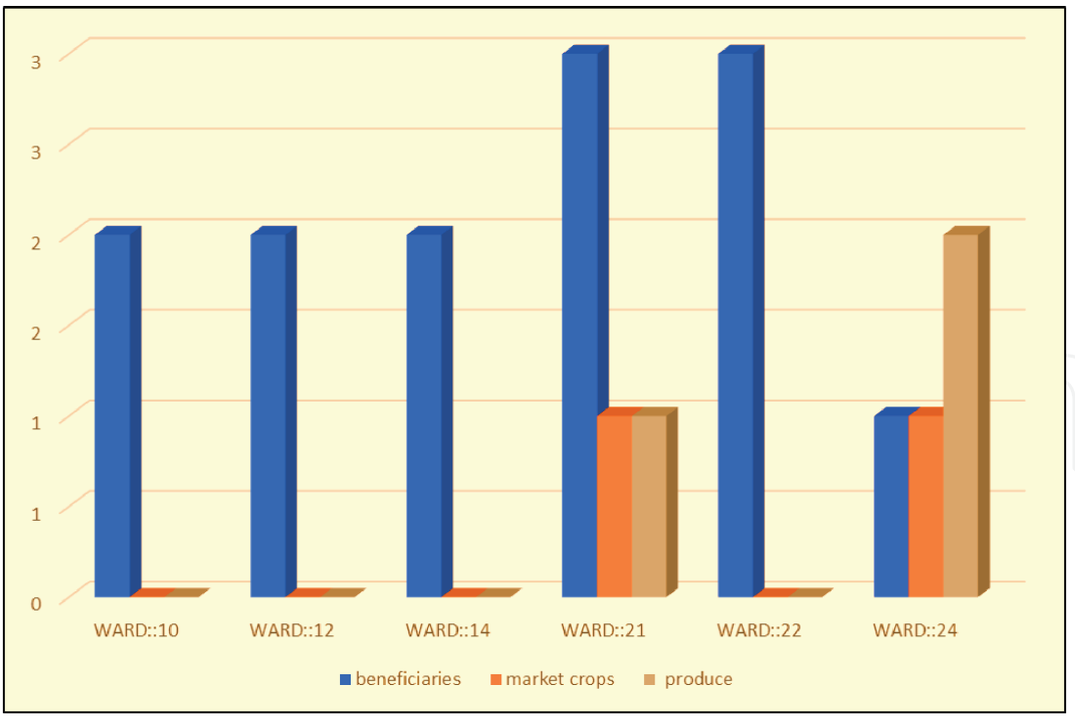

Figure 3.
Role of Chivi community in CA by Wards.

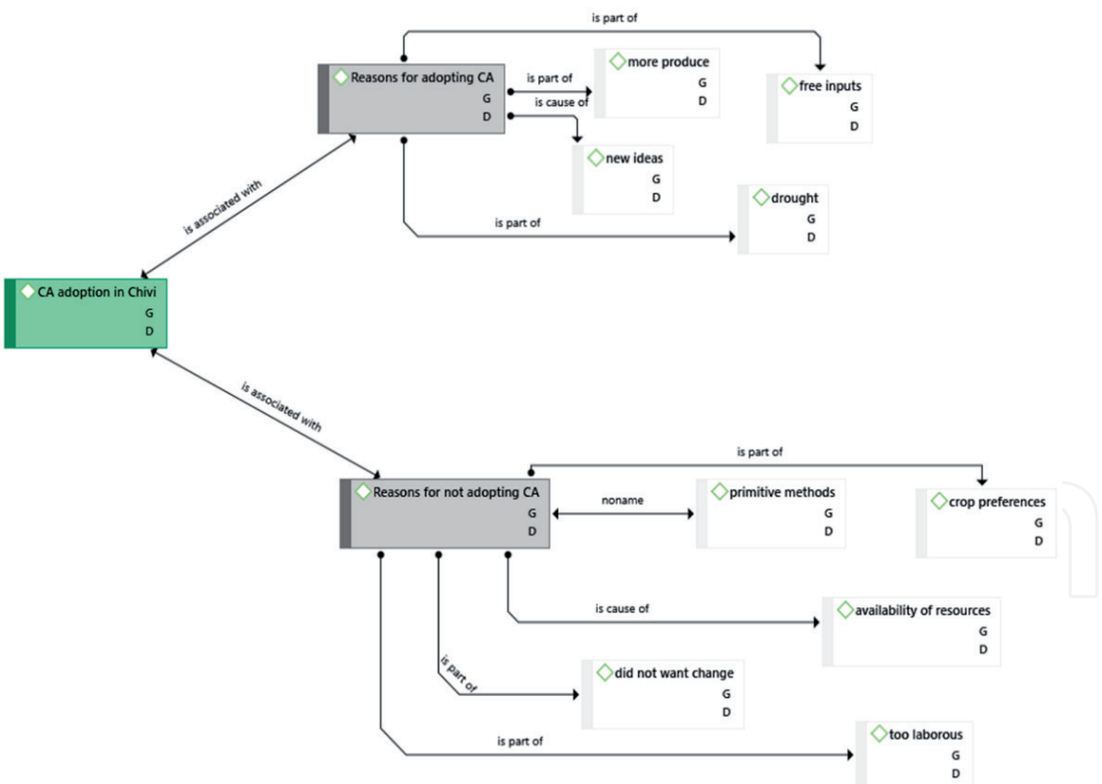

Figure 4.
Reasons behind CA adoption in Chivi District.

"Hapana akamborarama nedhiga udye, gore rezhara tose toforera mukomondera".

A Shona translation to no one has ever survived on CA, during drought, we all queue for food relief. This shows the community's negative view of CA as a disaster risk reduction tool.

Results on community buy-in showed that 80% of AREX officials described Chivi CA project buy-in as low. "Reluctant" and "not eager" were the most

commonly used adverbs to describe community buy-in. Drought was also mentioned as a barrier to community buy in. The benefits of CA are said to be less visible due to recurrent droughts. Chivi community through focus group discussions also confirmed low buy into the CA project but had different reasons, refer to **Figure 4**.

The focus group participants who adopted CA in Chivi, did it for diverse reasons, 34% adopted for new farming ideas, 32% adapted to curb drought effects, 17% for free inputs and 17% to increase production. The participants who did not adopt CA had also their own reasons, 34% did not see the need as they have enough resources to continue with conventional farming, 34% mentioned use of primitive farming and labour intensive methods, and 32% did not prefer small grains and changing their traditional farming system. All, 100% of participants who did not adopt CA were aware of the challenges faced in agricultural production however they did not see CA as the solution to their challenges. The interesting argument was that CA is affected by drought the same way as conventional agriculture system. This was also indirectly brought up by AREX and NGOs interviews. They attributed the negative attitude of farmers towards CA to lack of tangible benefits which are being washed away by recurrent drought in Chivi.

3.4 Factors affecting CA adoption

Variables of human capital were assessed through a questionnaire administered to household heads to unpack factors affecting the effective adoption of CA project as a drought risk reduction tool in Chivi. The impact of human capital on CA adoption were tracked using the demographic characteristics of household questionnaire participants such gender, age, level of education, marital status, employment status and household incomes. Adoption of a new agriculture technology does not only depend on the nature of the technology but also its intended users. Hence the heterogeneity of farmers and their demographic structure influence the adoption of a new innovation [18]. Gender is an important characteristic in the adoption of CA considering the associated gender roles and dynamics especially in rural communities. Age is influential in new technology adoption. Adoption of new technology declines with age [19].

Chi-square ($\chi 2$) test was used to associate demographic characteristics of participants with CA adoption. The findings showed a relationship between gender and CA adoption, refer to **Table 1**.

Variable	Chi-square	df*	p-value	Cramer's V
Gender	6.056a	1	.014*	.209[0]
Age	1.601a	3	.659	.107[0]
Level of education	3.493a	3	.322	.159[0]
Marital status	.280	2	.869	.0610
Employment status	2.249a	3	.522	.127[0]

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.
[0]*No relationship to weak.*
[1]*Moderate relationship.*
[2]*Strong relationship.*

Table 1.
Human capital and Conservation Agriculture.

The Chi-square ($\chi 2$) analysis revealed a significant association of gender and being a conservation farmer ($p < 0.05$). However a Crammer test classified the relationship weak. These findings are supported by other surveys done in Chivi, which showed that women constitute the majority of communal small holder farmers [20, 21]. This was also supported by the key informant interviews held with NGOs operating in Chivi. NGOs target women in their CA projects, hence more women have adopted the project. However with more women involved in CA, the project ought to have a special design tailor-made to suit women's gender roles and their often tight work schedules for sustainability. The CA activity plan used in Chivi contradicts this, CA project activities run throughout the year [22]. CA project in Chivi, runs concurrently with the conventional agriculture, the main and traditional agriculture system practiced by every farmer as well as livestock farming. Therefore time could also be the barrier to effective CA adoption and would certainly hinder its effectiveness as a drought adaptation tool.

The relationships between age, level of education, marital and employment status and CA adoption were found statistically insignificant. On age the findings showed that more participants were in the active age group, the 30 to 50 year age group, followed by 51 to 60 year group, then the 60 and above. Despite these findings of the Chi square tests, it is also important to note that the age structure of Chivi highlighted a community operating in a poor economic environment, considering that the active population is fully engaged in small holder farming as opposed to the norm that active population often work off the family compounds in towns and cities. It also showed that small holder farming is a major source of livelihood in this community. Therefore there is a need for sound agricultural innovations to boost livelihoods and curb drought effects. Chivi age structure consisting of a higher percentage of the active population, shows that the community is not negatively affected by new technologies which is ideal for effective information dissemination critical in CA adoption [23]. Younger farmers make long-term plans in their operations and acquire necessary skills and knowledge better than old farmers.

The level of education is also of paramount importance to information dissemination, comprehension of information and querying of information sources. Majority of participants had secondary education with a 58.6%. Participants with primary education were 37.1%. The least participants had a tertiary qualification about 1.4% followed by those who never attained any formal education with 2.9%. The findings shows that Chivi District comprises of a literate population. This means that Chivi community is very much aware of their environment and if given adequate information on CA, it can comprehend it and make informed decisions on adopting or not adopting. In this case low adoption of CA might be more to do with the applicability or feasibility of the project design and assets other than human capital.

Social dimensions such as marital status are also of importance in the adoption of a new agricultural system [24]. Marital status and gender are critical in decision making, especially in crucial issues such as adoption of a new farming system. Dimensions such as gender roles in decision making roles and land ownership come into play. Majority of the household heads who participated in this study were married, with a 58%. Single participants constituted 18% whilst 17% were divorcees and 7% widows. This married to non-married ratio of 58:43% is a true reflection of the marital status in Chivi. According to census report population of widows and divorcees is rising due to factors such as prevalent HIV/AIDS and economic hardships [20]. In a social structure such as this there is a need for developmental projects such as CA to strengthen weak social networks and support the existing ones and to avoid project domains that create or exacerbate social tensions.

Amount	Frequency	Percent
≤$227	97	69.3
≥$228	43	30.7
Total	140	100

Table 2.
Chivi monthly household incomes.

Despite an insignificant statistical link between CA adoption and marital status, inherent gender dynamics in marital status of a rural society such as Chivi needs a closer scrutiny. The strength of gender roles in decision making and land ownership might not be visible on the ground but has a huge indirect influence on adoption of an agricultural innovation such as CA [25]. These gender roles are well-defined in Chivi, a predominantly rural district with only 30 out 32 rural wards [20, 24].

An interview with key informants on gender gaps in Chivi also acknowledged existent gender gaps. NGOs had problems with the registering Chivi women to a CA sister project of Nutritional gardens. Most women would register into this project under their husbands' names some of which divorced them and some not even in the community, working either in the cities or outside the country. This shows that even though women are the producers they are not the decision makers nor practical land owners. This becomes a bit complicated when they have to make crucial and life changing decisions such as changing the farming system from conventional plough system to CA. There is need to mainstream gender into a CA project, lest it might affect the sustainability of CA or further widen the gender gaps that already exists in agriculture.

Financial capacity as well as off field commitments also influence the adoption of CA technology. Employment status of participants revealed that most household heads who participated in this survey were unemployed. At least 59% of the participants were unemployed. Very few participants were employed with a 3.6% and about 28% were self-employed while 10% were on pension. The findings showed that the rate of employment in Chivi is very low and people who are employed work outside the District [8, 21].

Household heads' monthly incomes were also analysed. The incomes were categorised using the United Nations (UN) poverty datum line of US$1.90 per individual per day [26]. This was calculated for a 30 day month and further multiplied by 4 which is the average household size for Chivi District [20], refer to **Table 2**.

Most participants, thus 69.3% had a monthly income below the poverty datum line while only 30.7% of the households were out of the poverty threshold. This supports the UN (2019)'s assertion that sub-Saharan Africa has most of the people living below the poverty line together with South Asia. In line with these findings, focus group discussions also raised an interesting argument on CA impact in the community. Participants who adopted CA from its inception mentioned free inputs as one major reason which made them buy into the project while the non-adopters argued that CA project had blocked the issuing of free drought relief food by NGOs. These arguments speak to the high levels of poverty in the community. Hence for CA technology to be acceptable in the community it has to prove itself as a viable income generating project.

4. Conclusion and recommendations

This study notes that adoption of the CA project in Chivi is low, with some farmers withdrawing from the project in ward such as 21 and 22. For a strategy to

be effective in the light of a disaster risk, it should cover all the affected people. Farmers are also still working on demo plots. Failure to transfer CA to their own plots and resorting to increase demo plots reflects that farmers do appreciate CA but they are barriers impeding CA practice on their own farming plots. Despite low adoption of the project, some CA practices have been adopted into the traditional farming systems. All farmers have at least adopted one CA principle and have incorporated it into their conventional agriculture system. This supports the view that CA has the potential as a drought adaptation tool. Crop rotation and use of small grains are the most adopted strategies, while mulching and planting basins are the least. These least adopted principles could be the barriers to effective adoption of CA project and effective adaptation to drought. Other barriers to CA adoption noted is the vulnerability of the CA system under a recurring drought environment. This support the assertion that farmers opt for a more viable agricultural option [13]. Hence CA option might be effective at smaller scale and farmers do not perceive the benefits at a larger scale. There is need for CA to be practiced on larger plots for tangible benefits and also for its high production during a better season to increase resilience of farmers during lean periods. The social discourse on CA is too negative, CA project officials need to involve the community in decision making as well as incorporate their local knowledge so as to build some sense of proprietorship and avoid knowledge contestations. On all factors affecting CA, gender and finance had the most significant impact. Gender dimensions such as overburden on women, land ownership and critical decision making powers need to be closely assessed and mainstreamed in the CA project. Finances heavily affect Chivi community where the majority of household heads are not employed and most households live on monthly incomes below the UN poverty datum line. CA concepts outside the project seem to be welcomed by Chivi community, hence for it to be an effective tool in drought risk reduction, more support has to be given to the community and NGOs need to take time in capacity building before rolling out the support. Future research can also look into finding common grounds in building resilient communities such as, blending indigenous and scientific knowledge into adaptation strategies as well as modifying agricultural extension models in rural areas.

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Conflict of interest

The authors declare no conflict of interest.

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