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# CLIMATE-SMART AGRICULTURE

## Improving dryland crop yields and value addition through university–community partnership in Zimbabwe

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### Introduction

Decreasing rainfall has worsened the food security situation of most smallholder farming communities in southern Africa that depend on rain-fed production systems. National agricultural production in Zimbabwe, especially from smallholder farmers, relies on rain-fed agriculture which is vulnerable to climate change and variability (Mandumbu et al., 2021). According to the Zimbabwe National Climate change response strategy of 2016, unless appropriate interventions are made, the negative impacts of climate change and variability on agricultural productivity will stress institutional structures at grassroots level. Communities living in the semi-arid natural farming regions which offer very limited livelihood options, make up 64% of the land area in Zimbabwe (Brazier, 2015). The focus of this CARP was on these semi-arid zones in the Mount Darwin district in the northern part of Zimbabwe and the Buhera South district in the southeastern part of Zimbabwe. These smallholder farming communities have been ravaged by the effects of drought. Marginalised local communities with traditional practices of agriculture are the first ones to face the impacts of climate change. The survival of these communities depends on the effective adaptation of agriculture to climate change. This project was directed at climate-smart agriculture to support small-scale farmers in the semi-arid communal farming areas of Zimbabwe.

Irrigation to increase agricultural productivity is expensive and very limited in scope. In the absence of appropriate infrastructure for capturing water at field scale, up to 50% of the rainfall can be lost from cultivated fields through runoff (Nyamadzawo et al., 2013). Improved in-field water harvesting technologies can conserve moisture that is enough to take the crop through drought stress periods reducing crop failures and improving household food security and livelihoods.

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Another adaptation mechanism includes the adoption of more climate change-resilient crops such as *Pennisetum glaucum*, *Eleucine coracana*, *Sesamum indica* and *Vigna unguiculata*. These are called Africa's neglected crops due to their non-coverage in international research and food systems. These drought-tolerant crops have largely been ignored. Typically, they are grown as food sources of last resort, and knowledge of their production, processing and marketing has not been effectively tapped. Furthermore, value addition of these crops has not been much explored. Maize (*Zea mays*) and groundnuts (*Arachis hypogea*) have more research available but were included in some of the CARP interventions in response to a request from the local farmers wanting technologies that could be suitable in their remote and semi-arid areas.

The community action research project (CARP) assessed water harvesting and strengthening crop value chains as an approach to address food insecurity and climate challenges. In-field water harvesting strategies such as tied-contour rain water harvesting systems are methods with the potential to increase the resilience of small farms to climate change. Improved in-field water harvesting technologies can conserve moisture that is enough to take the crop through longer drought stress periods hence crop failures are reduced and household food security is attained.

Marginalised communities (such as the CARP-targeted districts in Mount Darwin, the Zambezi Valley, and Buhera South) with traditional agricultural practices and very limited access to information and markets are vulnerable to climate change. They need to be able to improve yields of their drought-tolerant grains and legumes. And once a surplus becomes more available, they need information on proper grain handling, storage and value addition at community level. These farms are small and remote and marketing costs are high. They need to be supported to aggregate their production and work in groups to market and gain more market power. This will improve small-scale farmers' participation in the national economy.

The farmers in the two semi-arid districts selected for this project were trained in moisture conservation at field scale, design and management of the cropping system and post-harvest handling skills. The CARP gave them better access to information and training for improved productivity as well as value addition training for product development and marketing.

The CARP project brought an approach of shared vision and mutual understanding and trust building between the university and the communities. This approach contrasts with the ivory tower approach which sees the university as the only source of knowledge and innovation whilst the community is at the receiving end (Bowers, 2017). The university is located in a community and should play a role in the welfare and development of that community (Sathorar and Geduld, 2021). In Zimbabwe, this new collaborative approach supports one of the most important new roles given to the university by the central government: to interact with the community in a way that brings social and economic transformation (Education 5.0, Zimbabwe Govt.). Furthermore, the model used by the CARP project was not the charity model but the justice model. Morton (1998) reported that the charity model occurs when resources are given from the university community to another community whereas the justice model recognises that resources are mutual and shared amongst members of these same communities.

The Bindura University CARP focussed on millet (*Eleucine coracana* and *Pennisetum glaucum*), sesame, groundnut and cowpea value chains with a specific focus on production (moisture conservation and cropping system development), post-harvest handling, value addition and product development. The project also used locally available fruits growing wild, in particular, masau (*Ziziphus mauritiania*), to add flavour and value to the products. It was envisaged that after uptake of the water harvesting and integrated pest management systems, production would increase, and farmers will have surplus produce.

The specific objectives of this project were: to promote tied-contour rain water harvesting systems for improving small grains and legume production, capacity building of smallholder farmers in good agricultural practices, and the establishment of three value-addition and product development centres in the two districts.

## Small grains value chains in the target district

The participation of small-scale farmers in the small grains in the two CARP-targeted districts has always been limited to the production end of the value chain. These farmers produce the grain (including maize and legumes) and sell it to the middlemen who hire transporters and resell the produce in the urban centres for better prices. There is usually no value addition at community level except for home consumption. The farmers' produce is usually sold at very low prices. The CARP project intervened in the small grains and legumes value chain at production stage and at processing, value addition and product development stages.

## Project impacts

### *Student training*

One of the intended impacts of the CARP project was student training. Eleven students successfully graduated with Master of Science degrees (one from the University of Zimbabwe and ten from the Bindura University of Science Education) (Table 16.1). Their study areas covered tied-contour rain water harvesting systems, small grains production, post-harvest handling of grains and product development. They were supervised by researchers from multiple disciplines including crop science, environmental sciences, agricultural engineering, agricultural education, agricultural economics and extension. The crops studied included groundnuts, sesame, sorghum, millets and cowpeas.

The CARP project also supported technical and vocational training college students (TVETs) and the project partnered with Magamba Training College in

**TABLE 16.1** Postgraduate students

| *Name* | *Surname* | *Research topic* |
|---|---|---|
| Runyararo Evelyne | Motsi | An analysis of the impact of contract farming on the livelihoods of cowpea smallholder farmers in Mt Darwin District, Zimbabwe |
| Vimbayi Christie | Manyisa | Development of sesame food products to enhance food and nutrition security in Zimbabwe |
| John | Chinyama | Enhancing food availability from own entitlement through strengthened value addition of sorghum in semi-arid regions |
| Newman | Choto | Yield and Aflatoxin levels in groundnuts planted on ridges against flat seed beds under dry land farming in Mt Darwin |
| Andrew C. | Muzanenhamo | The effectiveness of integrated pest management in controlling cotton mealy bug (*Phenacoccus solenopsis*) in sesame (*Sesamum indica)* production under semi-arid conditions: the case of Mt Darwin district, Zimbabwe |
| Daniel | Machingura | Efficacy of ash, Garlic and chili on Fall armyworm, *Spodeptera Frugiperda* on the management of Maize |
| Fungisayi Susan | Makuzwa | The impact of Groundnut value chain commodity Associations on women farmers in Zimbabwe, Mt Darwin District Casa study |
| Merlin Carren | Kandima | The effect of sesame agribusiness (production and marketing) on small holder farmer's household food security |
| Tapiwa | Zengeza | Tied-contour rain water harvesting in sesame-cereal intercropping systems in semi-arid Zimbabwe |
| Desire | Marongwe | Developing a Sesame and sorghum-based porridge |
| Rudo Florence | Mapfeka | Influence of storage facilities on post-harvest losses of small grains in smallholder farming communities of Buhera South and Mt. Darwin Districts, Zimbabwe |

Mutare, Zimbabwe. The programmes included a diploma in agriculture and certificates in carpentry, building, welding and garment making. A total of 34 students were supported by the project and they have since graduated with various qualifications. These students came from remote farming areas where they would not have easily been able to access further education. Upgrading their skills made them more marketable for self- (or formal) employment and, also, brought their knowledge back into their remote farming home areas.

The collaborators in the Bindura CARP project were the farming communities of Mount Darwin and Buhera South Districts. The students participated in the demonstration set up of TCRWH systems and their evaluation by farmers. The project also collaborated with the Department of Agriculture Technical and Extension

Services (AGRITEX) where there was interaction with the extension officers who assisted in the implementation of the project. This deepened links with the university and, also, provided greater links between the agency and the communities.

## Community university partnerships

The CARP approach provided a platform for university-community partnerships and gave profound experience both to project collaborators and the students. The CARP approach was beneficial to the university as it increased its visibility within the community and enabled them to respond directly to the expressed farmer research needs. The establishment of farmer field schools[1] provided a lasting method for the introduction of new technologies to the communities. The CARP approach also enabled the establishment of a mutually beneficial relationship between the university and the communities. The setting up of the community value-addition centres provided opportunities to improve livelihoods and food security. The project also directly contributed to improving the welfare of youth in the area.

Another objective of the CARP project was capacity building of the lead farmers and extension officers. Across the CARP initiatives, over 5,000 farmers and extension officers were trained on tied-contour rain water harvesting, post-harvest approaches and farming as a business.

## Research results

The students engaged with the farmers to assess a range of technologies in their conditions and then worked with them to develop products. The CARP team held discussions with the farmers to determine what their key constraints were and M.Sc

**TABLE 16.2** Number of farmers trained on various aspects of the CARP project

| *Training* | *Number of participants* | *Skills imparted* |
|---|---|---|
| Tied-contour rain water harvesting systems | 4,000 | • Making the TCRWH<br>• Merits of TCRTWH and other attributes<br>• Setting up demonstration plots in farmers' fields |
| Post-harvest crop management | 1,000 | • Principles of drying<br>• Structures for post-harvest handling of cereals<br>• Post-harvest pests and their management<br>• Processing at farm level |
| Farming as a business, innovation and product development | 500 | • Farm records<br>• Equipment inventory records<br>• Profit and loss<br>• Gross margin budget<br>Innovation cycle<br>• Product development and commercialisation |

students then carried out research to address their concerns, in the process sharing knowledge and providing demonstrations for rapid uptake. Tied-contour ridges are small earthen ridges, 15 to 20 cm high, with an upslope furrow which accommodates runoff from a catchment strip between the ridges. The results reflected increased moisture retention. Intercropping systems were assessed and combined with integrated pest management to support farmers to improve yields. The use of a biopest mix of ash with a garlic-chilli mix proved to be an effective strategy for addressing the fall armyworm challenge. Farmers were trained using farmer field schools and a women's co-operative was supported with safe and higher-valued groundnut processing and marketing arrangements as well as equipment for processing. These interventions by the project helped farmers get better value for their crops.

Sesame/cereal intercropping under tied-contour rain water harvesting systems showed increased yields because of the higher (0.05) soil moisture content in fields with TCRWH compared to standard contours for both sesame-finger millet and sesame-maize intercrops. The highest moisture content was obtained from a one-metre distance from the contour and moisture became less and less with increasing distance from the contour. Sesame performed better as a sole crop than when intercropped. However, when productivity was measured using land equivalent ratios, the intercrops performed better than monocropping. An increase in sesame densities in sesame-cereal intercropping increased the overall productivity of sesame. The research concluded that when sesame is included at higher densities, the overall productivity is increased.

**FIGURE 16.1a** Village in Zambezi valley study area

**FIGURE 16.1b** Sesame farmer and Agritex officer

The tied-contour maintained higher moisture content across the post-planting period (Figure 16.3). Soil water content was higher in the tied contours at 1 metre and 13 metres from the contour although it was the same for both tied and modified standard contours at 7 metres from the contour (Mandumbu et al., 2021).

Groundnut production in Mount Darwin district is affected by poor agronomy hence this study sought to determine the effects of the method of planting and groundnut varieties on aflatoxin occurrence and productivity. One variety, Kasawaya which is a local variety, had the highest ($P<0.05$) mean pod count and a shelling percentage of 71.55%. Guinea fowl variety showed the least ($P<0.05$) leaf spot infection. Both methods (flat and raised bed) of land preparation did not significantly ($P<0.05$%) affect the aflatoxin prevalence. This reinforced the local farmer perspective of using the locally adapted varieties to optimise yield and to reduce aflatoxin.

An assessment of the factors affecting the use of post-harvest grain structures in small-scale farms in Mount Darwin showed that educational level, farm size, post-harvest training, access to extension services and total harvest increase the intensity of usage of post-harvest structures. Laboratory analysis showed that the highest grain damage ($P<0.05$) and grain loss occurred in the grain bags stored under kitchen conditions whilst the highest germination percentage occurred in the grain stored in a metal tin in the living quarters. The study recommended metal tins and plastic buckets for storage of grain, preferably kept in a granary.

## Product development

The University and the Mount Darwin community partnership has increased the productivity and crop yields of small farms. In addition, it has given rise to the development of products including an instant porridge made from pearl millet, sesame and *Ziziphus mauritiana* acting as a biofortifier and a flavourant. This product has passed the prototype stage and is nearing commercialisation and is branded as Dande Insta porridge. The CARP team has also produced Sopese porridge from sorghum and sesame. The team has produced sesame lunch bars (white and black), sesame butter, and sesame oil. *Ziziphus mauritiana* pulp has been used to make a beverage and peanut butter is now produced in the processing centres. The university community partnership has also produced a Rupiza (mixture of roasted cowpeas and peanut butter) for use as a protein rich soup. Preliminary market research and taste testing of all products is promising.

Most of the products are nearing the commercialisation stage. Preliminary market testing indicates acceptability and potential for demand even outside the rural communities. The CARP project bought equipment for product development which included a dehuller and a grinding mill which are housed in the university's innovation hub. Product development and commercialisation led to university-wide collaboration across departments which include the Department of Chemistry for product analysis, Department of Commerce for marketing and commercialisation and Department of Computer Science for social media branding.

The CARP project is in line with the Ministry of Higher and Tertiary Education, Innovation Development and Industrialisation which introduced the Education 5.0 policy in universities in Zimbabwe. The policy emphasises the role of the university in research, teaching, community service, innovation and product development. The policy places innovation and industrialisation at the centre of university functions. The CARP project has helped to raise the visibility of the university and the team members, positioning both as drivers at the forefront of innovation (The Herald, 2022).

The construction of the community value-addition centres also provided equipment and self-employment opportunities to youth and women in rural areas. It is a university-community partnership which indicates mutuality of the two entities. The CARP project provided building materials such as roofing sheets, cement and planks whilst the community provided the builders, labour, water and construction sand. The construction process took the shortest possible time because of the mutuality of the two entities.

## Shared university-community responsibility for building the value-addition centres

The CARP project university-community journey for the past four years has led to improvements in yields of up to 40%, ensuring food security for many of the

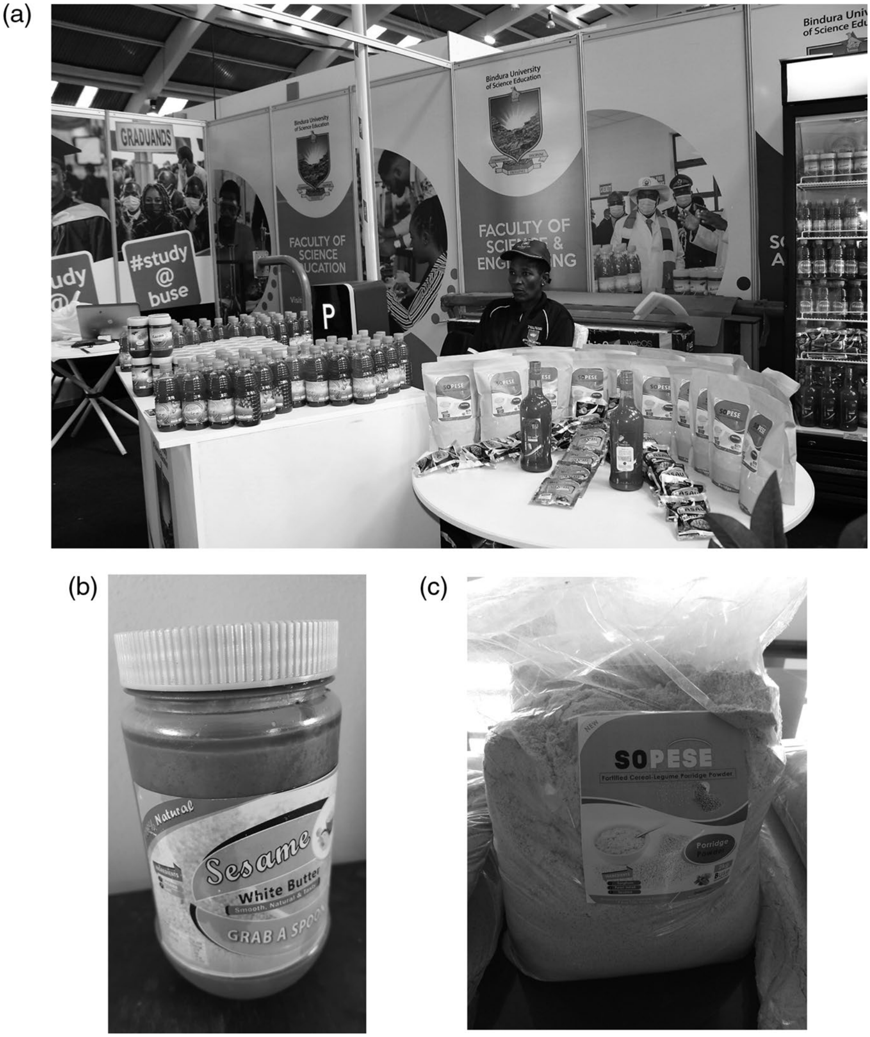


**FIGURE 16.2** Products at prototype stage on display at international conference: (a) displaying products, (b) sesame butter, (c) fortified sorghum, millet and sesame flour

poorly resourced farmers. The project also introduced the concept of community value-addition centres. The CARP project has made it possible for communities to produce products from the raw materials from their farms. The farmers can now make their own porridges, sesame oil and butter.

The CARP project helped to raise the profile of the university with local communities. The team benefited immensely through better collaboration. The project also introduced three farmer field schools through which the performance of the

FIGURE 16.3 Building Kaitano value addition centre

TCRWH system was tightly monitored and challenges were observed. It is a practical way of communicating new ideas to an audience and was effective as part of the CARP approach including the extension services and other researchers and stakeholders.

The CARP project has enabled BUSE to prepare educated, engaged citizens for addressing societal issues. The CARP project fulfils the call for institutions to become more responsive to the society's needs and bears the responsibility to research and share with the community. The work has only just begun and there are now opportunities for much greater collaboration between the university and the communities.

## Conclusions

The implementation process also had its own challenges including the COVID-19 disaster and the volatility of the Zimbabwean currency and logistical difficulties. This project has provided the farmers with more climate-smart options for facing the future. Areas for further research along the value chains include product development, improved marketing and the scaling up of farmer field schools and community value-addition centres. The CARP project improved the relations between the university and the communities where the project was being implemented. The development of products has opened opportunities for further collaboration with the communities in sustainable management of biodiversity with an increased focus on wild fruit trees and improved water harvesting and management of crops. The CARP project has opened opportunities for collaboration and bringing back the neglected, more drought-tolerant, crops back into the main food systems for the communities and the country. Given the challenges of climate change, the CARP provided a way for the BUSE researchers to be relevant to their communities and to strengthen climate-smart agricultural value chains in the semi-arid regions of

Zimbabwe. The project generated knowledge, produced products, graduated students, empowered the communities through establishment of community value-addition centres and farmer field schools and trained more than 5,000 lead farmers and extension officers. This project has highlighted the potential for universities to change their communities and contribute directly to national goals.

## Note

1 FFS is a farmer participatory approach where an innovation is applied jointly by a group of farmers on a field called the farmer field school model field (van den Berg et al., 2021).

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