Learning Brief - Biochar in agriculture in Mongu, Zambia

Production of biochar – practical training

1 Project background:

Biochar is a type of charcoal produced by pyrolysis from organic waste. When mixed into soil, biochar is stable, and thus its carbon is removed from the carbon cycle. This mitigates climate change and transfers a waste product into a valuable resource.

Due to its alkaline reaction, biochar also increases soil quality by reducing soil acidity. Especially in sandy soils, biochar can increase the water-holding capacity to alleviate water stress of plants. In addition, biochar can also reduce nutrient leaching, pesticide run off. All of these in combination can increase seed germination, plant growth and crop yield.

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The pilot project of People in Need was designed to serve as proof of concept to determine the extent to which biochar production and its usage can be adopted by farmers of smallholder farmers in Western Zambia as an effective and economically feasible practice to **increase their agricultural production and improve their livelihoods and resilience to droughts.** The focus was on farmers growing maize for subsistence.

From July 2022 until May 2023 the intervention targeted 20 lead farmers in 2 camps of Mongu (Sefula and Kande)

2 Methodology of Evidence:

An endline survey was carried out by the PIN Zambia team during July 2023 assessing the results of the pilot project. Additionally, soil samples were collected and analysed by Zambia research institute under Ministry of Agriculture from the target farmers (PIN is currently processing the results of the analysis).

3 Project Design

Problems identified at the start of the project were low agricultural productivity of small holder farmers in Western Zambia due to extreme climate vulnerability and low practice of climate-smart agronomy including conservation farming.

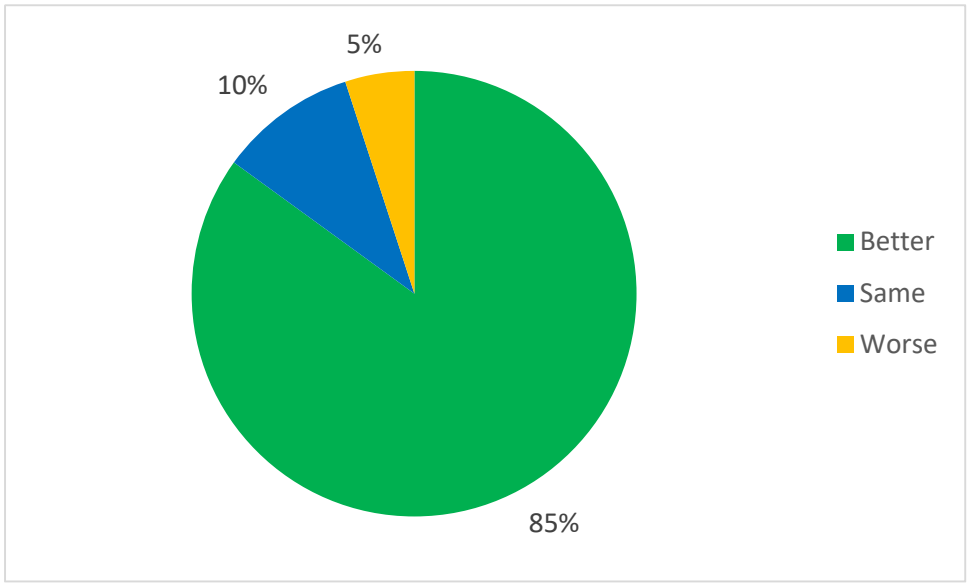
At the beginning 20 target lead farmers were selected based on in-depth interviews. A training in biochar production and application was carried out by project external key expert Gibson Simusokwe in both camps to target farmers, extension officers and PIN project manager. Subsequently, distribution of fertilizer and maize seeds was organized to target farmers and farmers were encouraged to source biomass for production of biochar – from their field of neighbouring fields. However insufficient amount of biomass was available so additional maize residues were brought from a location in Kaoma district. Finally, famers produced biochar and applied to their designated fields. Each farmer organized 2 plots next to each other, one treated by biochar with fertilizer, the other one without biochar. At the end an endline survey was conducted to measure the impact of the trial.

4 Project Impact

Difference between maize harvested from lines treated by biochar (left) and lines non-treated by biochar (right)

4.1 Performance of maize on biochar plots

85% of targeted farmers reported that the maize crops on plots where biochar was applied performed better than without it. And only 1 farmer (5%) reported worse performance of maize crops on biochar plots.



4.2 Willingness to continue producing and applying biochar

All 20 target farmers reported that they will continue producing and using biochar even after the project has phased out

4.3 Awareness of farmers of the benefits of using biochar

The table below shows the benefits of using biochar that were reported by the target farmers. All the 20 farmers (100%) were able to mention at least one benefit of using biochar.

Benefits of biochar	Number of farmers	Percentage
Moisture retention	16	34.8%
Improves soil structure	15	32.6%
Prevents nutrient leaching	6	13.0%
Improves soil fertility	5	10.9%
Rapid growth of crops	3	6.5%
Neutralises acids in the soil	1	2.2%

Table 1: Benefits of using biochar on the soil

4.4 Biochar production and crop yield

- In total, the amount of biochar that was applied by the farmers in both camps amounted to 2075 kg as reported during the endline survey based on the number of bags of biochar produced.

- Only 20% of the target farmers managed to harvest from their trial plots. The remaining 80% experienced crop failure and did not harvest from the trial plots.

Below is the comparison of harvest in biochar treated lines and non-treated lines among the 4 farmers who were able to harvest.

	Harvest of Maize (Kgs)			
	Biochar treated (with fertilizer)	Biochar Non-treated (fertilizer only)	Number of lines under trial	Agricultural camp
Farmer 1	14	3	7	Sefula
Farmer 2	13	2	7	Kaande
Farmer 3	10	2	10	Kaande
Farmer 4	9	2	5	Kaande

Table 2: Comparison of harvest in biochar treated and non-treated lines

The reasons that were highlighted by farmers to have contributed to crop failure were experience of droughts, floods, army worms, late planting of crops, and domestic animals grazing fields. Despite the failure, 85% of the farmers reported that maize crops where biochar was applied performed better during the growth process than the non-treated plots. Interest in biochar was raised among the farmers as well as among camp and district extension officers.

4.5 Carbon Removal Estimation

Based on the amount of biochar produced and applied to soil this allowed the removal of 2759.75 Kg of CO_2eq/year from the atmosphere.

The carbon reduction/removals potential for biochar could be up to 2-3 tCO_2eq/ton of biochar produced. In our case the calculation with VERRA VCS methodology had given: 1.33 tCO_2eq /year/ton of biochar applied in average (range from 0.73 to 1.93 tCO_2eq /year, if we consider the range on the parameter FCp identified in the methodology).

5 Lessons learned

The key lessons learned accumulated during the pilot from June 2022 to August 2023 are as follows:

- A key factor of making biomass for biochar available for production is ensuring that farmers allocate their crop residues (especially corn cobs) for biochar production already at the end of the previous cropping season. Avoiding burning them on the fields is key.
- Less biomass available resulted in less biochar applied to soil than originally planned
- Late planting due to the late training of farmers and production of biochar may have contributed negatively to the yield and army worm infestation. Army worm may spread more when planting is done late in the season.
- In order to ensure improved yields, biochar can help improve soil quality, however many other factors can affect it strongly so that biochar benefits do not materialize. Other preventive measures from floods, droughts, animal grazing and pest infestation are to be added, such as diversification of crops (pigeon peas suggested as a good combination with maize in Zambia), agroforestry, irrigation, biological pest management, early planting, etc.
- Clear marking of trial plots needs to be done during the application phase in order to evaluate well the impact. It is recommended to combine marking lines by wooden poles as well as recording the GPS coordinates of trial plots. Also measuring of the amount of biochar produced and applied is to be better tracked. This can be facilitated in the future (eg. by a module on the Nuru App developed by Pennsylvania University) for biochar production and application verification and subsequent certification.
- We did not target the youth at all, we were targeting male-headed HH mainly (80%) and the number of HH members were distributed from 3 to 12. We could use these criteria if we want to target some specific groups in next interventions
- We did not manage to produce a training manual for the replication during this phase. Training materials were supplied by external consultants in the follow-up phase
- There is a possibility of certification of carbon credits stored through biochar in soil. This is being explored for the next phase including the possibility to have payments for farmers for the production and application of biochar.
- However, follower farmers who don’t have direct experience with biochar have not kept sufficient amounts of biomass from previous harvest for production of biochar even if this was communicated to them during initial mobilization process. This needs to be taken in to account and perhaps consider some distribution of inputs (seeds, fertilizer) based on their mobilization of post-harvest residues as opposed to burning them in the field or using as fuel.
- In order to support farmers in securing enough biomass for biochar production, introducing of pigeon peas is being recommended by external

experts. This brings, diversification, is beneficial for the soil and pigeon peas residues form high amount of biomass very suitable for biochar production. Therefore, experts from NGI recommend to develop the biochar-pigeon peas value chain. PIN plans to test introduction of pigeon peas in the follow-up phase.

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