PROLINNOVA Ethiopia
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in ecologically-oriented agriculture and natural resource management

Biopesticide to control fall armyworm: local innovation by Gebreyesus Tesfay

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Axum, Tigray, Ethiopia

August 2018

Gebreyesus Tesfay and his biopesticide (Photo: Beza Kifle)

Gebreyesus Tesfay is a small-scale farmer who has developed a biopesticide that can control fall armyworm (FAW). He lives in the hamlet of Hagereselam in Kewanit *Kebele* (group of hamlets) in Tahtay Maychew *Woreda* (district) in Tigray Region of northern Ethiopia. The climate in his area is semi-temperate. Gebreyesus is 56 years old. He and his wife Saba Amare have six children: three female and three male. His main occupation is crop farming on about one hectare of land; the family also keeps some livestock (currently one cow with calf, two oxen, eight hens and one sheep). Especially raising and selling poultry and sheep provide him and his family with some additional income.

The farmer started developing his biopesticide in 2007. For this, he uses leaves of about 45 different plants plus goat urine and salt. He selects plant varieties with leaves that have a bitter taste, including the following known thus far only by their local names – *tsaeda kelamitos, shambako, gidae, nim, shmti, tsaeida engule, alke, tsaeda eka, engule, ere, lehay, htsawtsi, awusho, sur betray, tetaelo, awlie, trnaka, habi tselim, gesho, cheindog, tahsos, andel, harie kelbi*, *hambokita* – and the invasive shrub *Lantana camara.* His wife and two of his sons help him collect such plants near the homestead, whereas he collects the plants found further away. Using a knife on a stone surface, he and his sons chop the fresh plant leaves and then pound the leaf fragments in a mortar and pestle into still smaller pieces that

can dissolve easily in liquid. Gebreyesus puts the leaf particles into a 20- or 30-litre plastic container and adds only goat urine and salt. He leaves the mixture for 25 days until the leaf particles have disintegrated in the urine.

The goat urine comes from his own goats as well as from those of his cousins and neighbours, who collect their goats' urine every morning. At his own house, Gebreyesus has developed an efficient way to collect the goat urine. For keeping the goats overnight, he constructed a pen with a raised floor made from plant stalks on which the goats stand. The floor made of stamped earth beneath this raised floor has a slight slope going down to a circular hole at the bottom edge of the slope, where the urine coming from the goats gathers. This sloped ground is covered with plastic so that all the urine runs into the hole instead of into the earth.

The local name of his innovation is "*tsere balie*", which literally means biopesticide in the Tigrigna language. This innovation has benefited not only his family but also the entire community and even people who live further away in the towns of Shire and Axum. Some local community members obtain the biopesticide from him in exchange for goat urine or for free. These people do not have the patience to invest time in collecting the leaves and goat urine, learning how to make the biopesticide and producing it themselves. Although the work is time-consuming, the materials are all locally available and do not need to be bought. After the leaves and urine have been collected, the biopesticide is fairly easy to prepare.

When a new pest (now called FAW) appeared in his area in the 2016/17 cropping season, Gebreyesus tried his homemade biopesticide and found that it killed the new pest. He sprayed the biopesticide when his maize was about 0.5 m tall. He sprayed only in the evening to reduce volatilisation of the liquid. After that, he sprayed at two-week intervals, so that the moth had no chance to come and stay in the maize. After the third spraying, he stopped applying the biopesticide. His farm remained free of the pest whereas it affected the maize of his neighbours if they did not treat their plots or even if they used chemical pesticide.

Because this innovation is effective in controlling the FAW, the innovator and other farmers in the community can produce more grain (mainly maize and *teff*) and thus can attain greater food security and nutrition. Because the biopesticide is in fluid form and healthy plants are stronger, the innovation also makes the plants more resilient to drought. Killing the FAW on the crops and prevents its spread to other food crops such as *teff*, vegetables and forages means that the plants can continue their normal physiological activities and improve the quality of air in the environment and also can continue to produce.

Staff from Aksum University encouraged Gebreyesus to start selling his biopesticide for 200 Ethiopian Birr (about € 6) per litre. In one year, he was able to sell about 20 litres at this price because it is more effective in killing FAW than chemical treatments like Agoo, Bypel or Adepa, possibly because the agricultural extension services advise farmers to apply the chemicals after the maize plants are already infested by the FAW, whereas Gebreyesus advises farmers to use the biopesticide as a preventative measure**.**

In the 2017/18 cropping season, Gebreyesus collaborated with an entomologist from Aksum University, a crop protection specialist from the Tahtay Maychew District Agricultural Office

and a student from Aksum University (for documenting the process) in a joint experiment on this innovation. They were brought together by the Axum multistakeholder platform of Prolinnova–Ethiopia. Two of Gebreyesus' sons were also involved in the joint experiment, but his neighbours were not because they thought it would be too time-consuming.

In the joint experiment, the innovator and his co-researchers wanted to find out the effect of adding water during grinding of the different plant leaves, because the researchers suggested that adding water would facilitate the grinding process but Gebreyesus was afraid that the added water might reduce the effectiveness of his biopesticide. He said that he raised this question because (translated from Tigrigna) "people can grind the plant leaves with water, but I grind the plant leaves without water, so it is good to show the result or the difference." He explained to the collaborating researchers how he made the biopesticide, as an orientation for their work.

It was agreed that Gebreyesus would prepare his biopesticide as usual: chopping and grinding the plant leaves without adding any water, putting the material in a container, adding goat urine and leaving the mixture for 25 days. The researchers would do the same thing, but would add water during the pounding of the plant leaves and, after 25 days, sieve the mixture through a net to separate the liquid from the residual plant fibres, whereas Gebreyesus and his sons removed any plant matter by handed, squeezing out the liquid. The researchers thought that sieving was necessary to make it easier to store and spray the biopesticide. Both Gebreyesus and the researchers stored the biopesticide in 2-litre plastic containers in a cool and aerated place.

The innovator and the collaborating researchers used two knapsack sprayers with the different contents (the biopesticide prepared by Gebreyesus and that prepared by the researchers) to spray separately on two different plots of maize adjacent to each other on Gebreyesus' farm. The result was clear after one day. The main criterion to evaluate the results was the extent to which the biopesticide killed the FAW, judged by the number of living armyworms, if any, still to be found on the plants. The innovator's mixture proved to be better than the researchers' mixture: the product without any water added completely killed the FAW in the maize, whereas the mixture with water did not kill the FAW completely, probably because the water diluted the toxicants in the goat urine.

The innovator faced some problem with regard to the slowness of breaking down the plant leaves by grinding. The researchers could do this more quickly (also using a mortar and pestle) because of the water added during the milling process.

The student from Aksum University documented the findings for this report. The researchers and the innovator himself have been sharing with other farmers and researchers about the joint experimentation experience and the findings. They show photos of the killed and still living armyworms in the two plots that had been given the different treatments.

In their evaluation of the experiment, the innovator and the co-researchers agreed that the product without water was more effective in killing the FAW quickly so that it cannot spread to other crops. However, the process of grinding the plant leaves was less efficient when water was not added. In the end, they agreed that it would be better not to add any water to the plant leaves at any stage during the preparation of the biopesticide. In addition to the

documentation of these results by the student, Gebreyesus will tell this also to other people who want to prepare the biopesticide by themselves and will explain to his customers that he is selling them the finished product, which should not be diluted with water, as it will then be less effective.

To date, this is the only report that has been made on the innovation. The researchers involved from the university and the district agricultural office have not yet made a report on this innovation and the joint experimentation.