Solar energy gives small farmers new arms against insect pests

Validated RNRRS Output.

Smallholders are harnessing the power of the sun to reduce pest damage in their stored cowpea crops. In many zones of sub-Saharan Africa, farmers depend on storage to ensure supplies and sales over the long dry season. Previously, however, the cowpea or bruchid beetle (Callosobruchus maculatus) caused serious damage to stored crops. The solution is simple but effective: appropriate exposure of cowpeas to the sun leads to a temperature rise that kills most if not all of the pests—eggs, larvae and adults—on and inside the grains. This technique is being used by smallholders in 40 villages in Ghana, as well as by farmers in Uganda.

Project Ref: **CPH28:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Post Harvest Programme**

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Ghana, Uganda,

Target Audiences for this content:

Crop farmers,

Document Contents:

Description

CPH28

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Low cost and safe pest control for the storage of cowpea by small scale farmers

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Crop Post Harvest Programme

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

R6503 (1996 – 1999) Improvement in the storage and marketing quality of grain legumes

R7442 (1999 – 2002) Improvement in the storage and marketing quality of legumes (Phase II)

Lead Institute: **Natural Resources Institute**, University of Greenwich.

Lead Person: Dr Bruno Tran, Associate
E-mail <bmdtran@tiscali.co.uk>

Partners and respective organisations:
Mr Fuseini Haruna Andan, Ministry of Food and Agriculture, Northern Region, Ghana; Email <princefuhaan@yahoo.co.uk>
Dr Ambrose Agona, Kawanda Agricultural Research Institute, Uganda; E-mail <aagona@hotmail.com>
Mr Stephen Ecwinyu, Matilong Mixed Youth Farming Organisation, Soroti, Uganda; E-mail <secwinyu@yahoo.co.uk>
Mr Herbert Okurut-Akol, Serere Agricultural and Animal Production Research Institute, Soroti, Uganda

*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

The Problem: the bruchid beetle, the main and pervasive pest of stored cowpea.

In the dry zones of sub-Saharan Africa cereals and legumes once harvested must be stored throughout the long dry season if food is to be available, or if households are to have the option of selling their grain. Selling later in the dry season commands higher prices, due to relative scarcity. **Cowpea** (also known as black-eye bean or black-eye pea) is a widely grown **legume** in the tropics, and the traditional varieties, which are drought resistant, are especially well adapted to relatively poor growing conditions. **Small scale farmer**s often however find that the cowpea beans are severely damaged during **storage** by an **insect pest,** the cowpea or **bruchid beetle, *Callosobruchus maculatus***.

The Solution: solar energy.

The output is a simple but effective **solarisation technique**, which harnesses the power of the sun to reduce pest damage on stored cowpea to acceptable levels.

In tropical regions, the sun is a powerful and reliable source of energy and **simple technologies** can make use of this free resource. Appropriate exposure of cowpeas to the sun can lead to a temperature rise sufficient to kill most if not all of the pests – eggs, larvae and adults – on and inside the grains.

Germination tests showed that grain stored for seed remains viable.

The technique in short:

- Dried cowpea grains are spread in a thin layer on a flat area of ground where sun exposure will be high for a whole day. The ground should be cleared of debris.
- To avoid contaminating the grains and to improve temperature retention, locally available (e.g. straw) mats are first arranged on the floor and covered with second-hand jute sacks.
- The layer of cowpea grains on the jute sacks should not be thicker than 2 or 3 cm (1 finger's joint when probing the grain).
- The spread cowpea grains are covered with a thin transparent polythene sheet, which is held in close contact to the grain with weights (stones etc).
- It is important to keep animals (goats, chicken etc) away from the cowpea during the treatment.
- Sacks or containers in which the cowpea is stored should be cleaned during exposure to the sun to avoid re-contamination.

Repeated monthly during the storage season, this treatment offers very good levels of protection for a limited initial investment.

The technique is described in detail and with graphical illustrations in two extension booklets prepared within the project, one for extensionists and one for farmers. Available here http://myweb.tiscali.co.uk/cowpea/homepage.htm

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
	X		X		

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

The main commodities for research were cowpea and bambara nut.

The technology could easily be extended to any dry grain or food product that can be heated to about 60-70 degrees C, that is stored in quantities of 1 to circa 500 kg, and is subject to insect pest attacks where larvae develop inside or on the grain, consuming its reserves (e.g. maize, millet, rice, cassava chips etc).

Tests would first need to be undertaken to ascertain treatment effectiveness and acceptability to users. Effectiveness is likely to be dependent on the length of exposure and regularity of exposure which ought to be tested for each new commodity. Tests on user acceptability would cover cooking times and palatability. Tests on seed germination after treatments would be essential if treated grains were intended for use as seeds.

The technology is unlikely to be appropriate for larger quantities, but feasibility checks could be undertaken, for specific cases.

The method requires strong sunshine for most of a day, and is most applicable to hot and dry climates.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options.

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
X	X	?	?	X			

? Dependent on available sites with sufficient exposure to the sun.

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
X	X			X	X	

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300***

words).

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

Responsive service provision. The technique is particularly suited to poorer households with relatively small amounts of stored grain. As such it would fit in well with extension service initiatives that attempted to provide information to meet the priorities of a range of different households and groups (e.g. 'basket of options' approaches).
R8429, R8281, Linking demand with supply of agricultural information

Clustering on cowpea. From the perspective of clustering technologies useful for improved cowpea production and storage, and providing small-scale farmers with the means of improving their access to markets, the following are relevant.
R8411, R8300, R7441, Pheromone traps-Maruca vitrata
R8414, R7965, R7568, R7569, R8316 Promotion of bean ICPM
CRSP cowpea work (see details below)

Clustering on storage pest control. Storage pests and their means of control have common characteristics. From an educational / training perspective the output could be part of a portfolio on storage pests covering non-chemical and safe control methods, integrated pest control and the safe use of chemical insecticides.
- Integrate in general small holder stores hygiene approach (GTZ, FAO manuals)
- Safer use of pesticides/alternatives in rural poor areas. Cluster with work of PAN (http://www.pan-international.org/pan-v1/africaEn.html)
R7034 & R8179 Diatomaceous Earth
R6311, R6684, R7486, R8265 Pest management tools and strategies

Clustering on storage. A variation (or elaboration) on the previous cluster might include more general storage technologies and techniques for extensionists and smallholders (e.g. stores building, basic storage hygiene and even marketing issues for stored products).
R6658 (R6502/R6684) Improved design of indigenous grain store - mud based silos
R8274, R8498 Farmer access to markets
R8275 Farmer access to markets
R7151 Market information tools
R8250 Market information tools
R8422 Improving farmers and other stakeholders access to pre- and post-harvest information

Clustering on solarisation.
- The US financed CRSP, a West African cowpea programme, has worked on a similar but more expensive approach. It has collaborated with the Swiss funded PEDUNE programme which extended the technology in the Sahel and African Savanah. See the CRSP web site:
http://www.entm.purdue.edu/Entomology/research/cowpea/main.htm
- Some solar drying techniques (e.g. fruits) may provide complementary information.
- A solar disinfestation approach has been developed by EAWAG and SANDEC to treat drinking water: SODIS or Solar Water Disinfection, which improves the microbiological quality of drinking water, using solar UV-A radiation and temperature to inactivate pathogens causing diarrhoea. See their web site: http://www.sodis.ch/

Validation

B. Validation of the research output(s)

10. ***How*** *were the output(s) validated and* ***who*** *validated them?*

Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation ***(max. 500 words)****.*

In Ghana: 95 farmers from 2 villages in the Northern Region ran farmers' trials. The farmers applied a selection of the best insect pest control methods which had been validated previously on-station and on-farm by researchers. Three control methods were: solarisation monthly, solarisation at harvest followed by admixture of ash, and solarisation at harvest followed by admixture of shea nut butter. These methods and a non-treatment comparison were allocated randomly amongst the farmers, who after training, applied the treatments to small quantities (20 kg) of their own cowpea, and stored them in their usual store. Farmers and researchers monitored the cowpea throughout the storage season. The treatments were judged by the farmers according to several criteria (e.g. effectiveness, ease of use, affordability, etc.). Farmers also ran germination tests to ensure the treated grain could be used as seeds. Monthly solarisation emerged as the overall best protection method, with single solarisation and shea nut butter seen as effective, but only for specific purposes (e.g. seeds) because of the smell/taste.

In Uganda: 150 farmers in several villages from 6 sub-counties were trained and applied the same control methods and non-treatment. Training was provided by local NGO staff, government extension agents and link farmers. Participating farmers monitored damage during the storage season and provided a judgement similar to their Ghanaian counterparts, identifying monthly solarisation as the preferred treatment. There were two major variations: (i) solarisation once with admixture of ash was perceived as a good control method (as supported by damage levels recorded by the farmers themselves), but solarisation once followed by admixture with shea nut butter was not liked (ii) rains and cloudy skies were noted as a constraint to solarisation in this part of Uganda.

User groups: Most of the participating farmers had surpluses for sale or trade, and fell within the "moderate poor" grouping. The villages selected were representative of the respective districts (i.e. generally poor) albeit within the villages there were variations in wealth. Participation in the project generally precluded individuals from the "extreme vulnerable poor" grouping, as they were unlikely to generate or be able to retain sufficient surpluses. Participants included women and men, young and old farmers.

Increase in productivity: the decrease in damage on stored cowpea was precisely documented in the project report, which details the decrease of loss of production in terms of weight and cost.

Partner organisation: in Ghana, MoFA (Ministry of Food and Agriculture) was the main partner and has included the technology in its extension portfolio. It is now being extended by the ministry's extension agents in the Northern Region (see below). In Uganda, NARO (National Agricultural Research Organisation) supports solarisation of cowpea, but is promoting a slightly different methodology.:
see http://www.coard.co.uk/section11.php#pulses.

Adoption after four years: In Ghana uptake of the technology is reported in the two villages and replication has occurred in neighbouring villages. No adaptation of the technology is reported. In Uganda, farmers and small traders in the validation districts continue to use the technology, except in the zone afflicted by fighting. In two districts outside the validation districts but within reach of farmers' associations and extension programme, adoption is reported on a large scale.

*11. **Where and when** have the output(s) been validated?*

*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

Farmers validation took place in 2000-2001 in the villages of Kpugi and Wantugu, Gushegu/Karaga district, Northern Region of Ghana and in 6 sub-counties in the Teso districts of Kumi and Katakwi in Uganda.

Social group: see section above

Semi-arid Production system (cowpea, especially traditional varieties, is well adapted to drought; solarisation requires dry and sunny weather) although also relevant to Peri-Urban in semi-arid areas. Smallholder Rainfed Dry farming system.

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words)**.*

In Ghana, the technology is being used by small-scale farmers in the validation and neighbouring villages of Gushegu/Karaga district. They are using it to treat small quantities of cowpea (100 – 200 kg) which is being stored for home consumption and/or later sale. No modification of the technique has been reported.

In Uganda, farmers in Kumi, Amuria and Katakwi districts are using the technology (i.e. solarisation on a monthly basis, adding wood ash and shear nut butter) to protect their cowpea seed from damage, directly as a result of the validation trials. These farmers are involved in small-scale family level production and typically store 100 to 200 kg of cowpea. Small-scale traders are also using the technology. They are storing up to 2000 kg of cowpea, amongst other commodities. Some farmers have adapted the technology, replacing shea nut butter and ash admixtures with Moringa leaf powder, Neem tree leaves, red pepper or Tobacco.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

Solarisation is known to be used in the Northern Region of Ghana. Farmers in the two villages where validation took place in Gushegu/Karaga district are still using the technology and report that it is effective (survey by MoFA, October 2006). Adoption in these villages is estimated to include an additional 260 and 130 farmers respectively over and above those involved in the original 2001 validation. MoFA extension agents moreover have reported that 10 neighbouring villages in the district have adopted the technology.

In Amuria and Katakwi districts, Eastern Province, Uganda, earlier adoption was scuttled by the Lord's Resistance Army's attacks in 2003–2004. Cowpea production has remained low and was even worse in 2006 leaving no surplus for storage, with farmers sometime even lacking seeds for the next season.

Adoption has picked up in Kumi district, and even more so in Malera and Bukedea districts, which are the main production areas of cowpea in eastern Uganda. Good quality seed is needed to maintain the export market with Kenya. Cowpea production is a key livelihood activity here, not only for consumption but also for income. Farmers have adopted solarisation because it leaves the seeds clean and good for consumption. Small scale traders use the improved quality to access a better market. The technology has also transferred to the neighbouring districts of Mbale and Sironko, where it is reported that it is being used to protect maize from damage during storage.

14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading ***(max 250 words).***

Ghana: MoFA extension agents in the Northern Region of Ghana estimate that the number of farmers using solarisation in the Northern Region could be of the order of 5 to 6,000. This estimate corresponds to 40 villages in the 18 districts of the region. Figures for neighbouring regions, Upper East and Upper West, where cowpea is also widely cultivated are not known at this stage.

In Eastern Uganda, the Katakwi Farmers Association reported having extended the technology to other farmers beyond those initially involved in the validation trials. Farmers interviewed said they had been approached by other farmers in their localities who were promoting adoption within their villages during the first two years after validation (2002 – 2003); no additional adoption was reported after 2003. By contrast, in Kumi district, farmers reported that they had undertaken drama shows on the technology as part of another programme in 2002, resulting in widespread adoption, and this has continued to this day. It was also possible to interview some traders, who were not involved in the validation trials: they said the technology was very effective and its use profitable, allowing them to command better market prices. The estimates by farmers in Kumi projected the number of farmers using the technology to-date (2006) to be in the 100s in their localities, and into 1000s across the boarder into Mbale and Sironko districts.

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

Promotion of the solarisation technology in northern Ghana was largely treated in conventional *technology transfer* mode. Following the success of the research trials, government and NGO agricultural extension agents (AEAs) were trained in the technique, and invited to share it in their respective constituencies. The drive for this initiative came largely from the officer heading up the Post-Harvest Unit (PHU) in MoFA, Tamale, Mr Fuseini Haruna Andan, who had also been the main interface with the lead research organisation, NRI. Mr Andan enjoyed significant flexibility in his role and was able to apply a measure of entrepreneurship to the promotion of those technologies in whose validation he had played a role.

Throughout and since completion of the research project MoFA has been undergoing reform, including decentralisation, but there was no evidence in late 2004 to suggest that the new agricultural extension policy or its implementation strategies, drafted in 2002, had effected changes that were specifically assisting the promotion and adoption of this output. This is not to suggest that the changes to the extension services were not necessary, rather that restructuring and much needed strengthening of capacity will take commitment and time to deliver benefits.

The situation in Uganda was different again. A key coordinating NGO, Matilong, district NGOs and farmers' association, had been instrumental in the research, and in disseminating the technology. Dissemination was also supported by the locally-based NARO – DFID Client Oriented Agricultural Research & Dissemination (COARD) Project, which funded the production of extension materials, including farmers' drama groups. Farmer participation in the promotion of the technology is also seen as having been crucial to the promotion (e.g. drama shows by farmers trained under the Matilong Extension Development project resulted in high rates of adoption in Kumi). In recent interviews farmers have also said that the sub-county extension system was very effective in disseminating the technology.

Dissemination also resulted from small-scale traders demonstrating the technology and telling farmers that they would readily buy their cowpea if it was well preserved using the technology. Farmers' associations in some locations have facilitated access to the polythene sheets.

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Solarisation, even more so were it part of an Integrated Pest Management approach, provides a tested, effective, affordable and acceptable alternative to the use of chemical pesticides for the control of stored legumes, other grains and dried products. In Sub-Saharan Africa, pesticide misuse is widespread, including unregistered or adulterated chemicals, products of unknown origin, ignored, unavailable or unknown application dosage and recommendations. Two common practices for pest control on stored cowpea are, phosphine fumigation without the required hermetic containment for several days, and the use of subsidised cotton pesticides resold for profit. Phosphine fumigation without a gas-proof containment results in ineffective treatment that can lead to the development of resistance to the insecticide. It also presents a health risk through exposure to the escaping gas. Chemicals designed for pest control in cotton fields are typically long-lasting and dangerous if used on foodstuff (reference: http://www.pan-uk.org/pestnews/issue/pn53/pn53p4.htm).

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? (max 100 words)

There are no adverse environmental impacts due to the application of the technology. However, for cases of widespread use, the issue of disposal of old polythene sheets will need to be considered.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? (max 200 words)

By offering small scale farmers a cheap, sustainable as well as environmentally friendly option for maintaining the quality of their stored products and hence making their harvest last longer during the dry season, the technology will increase their resilience.

For those areas where mean daytime temperatures are expected to increase, there should be increases in the effectiveness of solarisation.