Trench warfare to combat crickets in southern Africa

RIU

Validated RNRRS Output.

Crickets that devastate crops can now be kept out of fields by simple trenches or narrow barriers of insecticide. Sorghum and pearl millet are the main subsistence crops in eastern Botswana and much of southern Africa. The Armoured Bush Cricket seriously affects both. But, farmers are reluctant to spray pesticides because they consider them dangerous. Now, farmers simply dig half-metre deep trenches around their fields. Marching crickets, once in the trenches cannot get out. Putting bait in the trenches or encircling fields with narrow bands of insecticide also works, but most farmers are happy just with trenches. Now the trench system has been proven on research stations, extension workers and farmers are keen to try it out during the next cricket outbreak.

Project Ref: **CPP68:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP68

A. Description of the research output(s)

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

Geographical regions included:

Botswana,

Target Audiences for this content:

Crop farmers,

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.

Control of Armoured Bush Cricket in southern Africa

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

CPP

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.

Projects:
R8253/R7428

Partners:

[1]Dr Stuart V. GREEN
NRI Research Associate, 31 Naseby Road, Belper, Derbyshire DE56 0ER, stuvigreen@hotmail.com Tel. 01773 880436

[2]Dr John HOLT
NRI, University of Greenwich, Chatham Maritime, Kent ME4 4TB
E-mail: J.Holt@gre.ac.uk Tel: 01634 883225

Dr L. M. MAZHANI
Director, Department of Agricultural Research, P.Bag 0033, Gaborone, Botswana
E-mail: lmazhani@gov.bw

Mrs Jannette D. MITCHELL
ARC-Plant Protection Research Institute, P.Bag X134, Pretoria 0001, RSA
E-mail: rietjm@plant2.agric.za

Dr Pharoah O P MOSOPI
Sebele Research Station, Private Bag 0033, Gaborone, Botswana

Dr Patrick J Z MVIHA
Department of Zoology and Entomology, University of Pretoria, Pretoria 0002, RSA

Prof. Clark H SCHOLTZ

Department of Zoology and Entomology, Faculty of Biological and Agricultural Sciences, Univeristy of Pretoria, 0002 Pretoria, RSA

Dr Johny VAN DEN BERG
ARC Grain Crops Institute, P Bag X1251, Potchefstroom 2520, RSA

Dr L J WADHAMS
IACR Rothamsted, Harpenden, Herts AL5 2JQ, UK

[1]project leader R7428, joint project leader R8253
[2]joint project leader R8253

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.*

Sorghum and pearl millet are the main subsistence food crops in eastern Botswana and throughout much of southern Africa. Both crops suffer serious damage due to Armoured Bush Cricket (ABC), principally *Acanthoplus discoidalis*. It was estimated that the 1990/1991 ABC outbreak in Botswana resulted in 40% losses of sorghum in those regions affected, whilst total millet losses to ABC in Namibia during the 1993 outbreak was estimated at 30% (Wohlleber, 1996). There is general concern amongst farmers in those countries affected by ABC that outbreaks of this pest are becoming more frequent as well as more damaging when they do occur. ABC is considered the second most damaging crop pest in the Central Region of Botswana just behind Quelea. Hence there is a need to develop and implement measures that farmers can use to manage this pest and thereby reduce losses to key cereal crops.

None of the existing control measures were considered effective by farmers and a belief that nothing can be done was widespread. Framers were very concerned about pesticide safety and previously-used surface application of baits and general spraying of crops was regarded by them as unacceptable. The output provides two novel approaches to ABC control developed during the RNRRS – the baited trench and the fipronil (insectide) sprayed barrier. ABC biology is highly synchronised with that of the crops and as a result of the CPP projects it is now known that ABC spend there earlier nymphal stages in the bush, only moving to crops as late instars or adults when the crops reaches panicle emergence and provides an attractive food source. ABC is flightless but marches from the bush into the crops en mass when the time is right. The technology offered involves the use of trenches dug around the crops, or insecticide barriers applied to a strip pf ground around the crops, to intercept the marching crickets. The design of the trenches is critical to minimise escape and poisoned baits may or may not be placed in the trench to kill the crickets trapped therein. Both approaches offer a highly targeted use of insecticide that poses minimal threat to people or the environment. Framers expressed a willingness to adopt the technologies, particularly the trench option. A further technology is offered as a spin-off to ABC control, namely utilisation of ABC as a valuable, high-protein poultry food.

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	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

Mainly sorghum, millet and maize. Although ABC is highly polypahgous and is generally attracted to high nutrient food sources, sorghum and millet crops predominate in the semi-arid habitats in which this pest occurs.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

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

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).
Leave blank if not applicable

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

*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.

There is a possible migrant pest cluster including pests like ABC that have some of the outbreak characteristics of migrant pests and fall under the same institutional bodies that are responsible for migrant pest control. This cluster might include armyworm forecasting (R8407/R7966/R6762) armyworm novel control (R8408), Quelea (R8426, R7967, R6823, R8314), brown locust (R7779), and ICOSAMP (R8315, R7890).

The technologies this output offers for ABC control, however, are locally based crop protection measures rather than any form of strategic control. There may therefore be potential for value to be added by clustering with other research outputs that operate at the same village level, and in the same countries/districts that ABC occurs. Potential candidates from the profile list that may meet at least some of these criteria are listed below but the potential for mutual benefit has not yet been explored further:

- bean ICPM (R8414…) E Minja;
- integrated maize crop management (R8219...) P Seward;
- pest and soil management, maize (R8452…) A M Mbwaga;
- communication, semi-arid systems (R8428…) A Sutherland;
- pest and soil fertility management (R8449…) Z R Khan;
- access to markets (R8275) A Dowrd; (R8274…) A Agona;
- grain store mud based silos (R6658...) R Hodges;
- pest management (R6311…) R Hodges;
- uptake promotion (R8381) N Hatibu;
- goat production (R7634) C Ahuya.

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)**.*

A farmer training day, staged in April 2002, demonstrated the ABC control methods to more than 200 farmers. In particular, the baited trench (a 30cm deep, vertical sided trench containing small quantities of a carbaryl/bran mixture bait) was demonstrated as the most appropriate control method for smallholder farmers to deploy against ABC. This method was tested successfully on-station at Sebele, Gaborone in 2001 but due to an absence of ABC outbreaks in the last two years of the CPP projects, there has not been an opportunity to test the method on-farm. A substantial majority of farmers interviewed at the training day stated they wanted to test out the baited trench during the next ABC outbreak, so an opportunity exists for extensive on-farm testing of this method.

Barrier spray application of fipronil was previously tested on-farm against ABC during the 2000 outbreak and found to be effective. A subsequent environmental impact assessment demonstrated that both barrier spraying and the baited trench had only a short-term effect on non-target invertebrate species. These two control methods appear to be the most promising, both in terms of their effectiveness and the likelihood of their being adopted.

In addition to these two control methods, it was also felt that a third management option against ABC, the unbaited trench, merited field-testing if an opportunity arose. Although a 30cm deep unbaited trench did not perform nearly as well as the equivalent baited trench when tested on-station, a somewhat deeper (50cm) unbaited trench did retain 79% of crickets for 24 hours. Since many farmers have misgivings about using pesticides (Matsaert et al, 2000) this method would be more acceptable to some farmers.

In the Shoshong field trial in 2003 (see below) insufficient ABC were present for a conclusive evaluation. The mean number of ABC was consistently lower in baited trench plots than the controls but not significantly so. The baited trenches were observed to kill many ABC, and the sight of so many dead crickets in the trenches had clearly convinced the farmers that this control measure was very effective. Development and testing of mechanised trench digging devices was undertaken. Trench practicality and effectiveness depends on soil type, too heavy and digging is difficult and the crickets can also gain purchase to climb out, too sandy and the trench sides collapse. In ideal soil conditions the trenches can be dug reasonably easily and do not collapse but is sufficiently friable to make if difficult for the crickets (very heavy insects) to obtain sufficient traction to climb out. The approach is definitely more suited to particular soil types but whatever the soil conditions, trench maintenance is important for successful control of ABC. Farmers were enthusiastic but their chief concern was the labour input needed if trenches were to be dug by hand. Trench construction is very laborious, especially on heavy soils.

*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)**.*

On-station validation took place at Sebele, Gaborone, Botswana. The farmer demonstration day tool place at Shoshong, near Mahalape, Botswana. Field trials for on-farm testing of 1) the carbaryl-baited trench, 2) barrier spraying using fipronil and 3) the unbaited deep trench, were planned for the 2003 growing season. The location selected for the trials was the Shoshong area in central eastern Botswana, an area that is severely affected by ABC and where the project had previously established good relations with farmers and local extension staff.

An ABC outbreak was necessary in order to properly evaluate the three control methods. Early rains in 2003 were poor however, and by mid February, field reconnaissance suggested that it was unlikely to be an outbreak year. However, the numbers of ABC nymphs present in scrub fallow areas (their favoured habitat) were markedly higher than during the two previous seasons and so preparations for the trials went ahead. As the growing season progressed and the sorghum crop reached the heading stage, aggregations of ABC gathered at some field edges and an ABC field invasion later took place. This was, however, some way short of the sustained influx of ABC that is seen in a full-blown outbreak situation.

Current Situation

C. Current situation

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

Primary stakeholders were targeted via secondary stakeholders: the ABC specialists from ABC-affected southern

African countries who attended the ABC symposium. These individuals received copies of the extension booklet, *Biology and Control of Armoured Bush Crickets*, produced during the CPP project, for distribution amongst the extension service and the agricultural research department in their respective countries. Through this means the recommended measures to protect crops from ABC during an outbreak were disseminated to the ultimate intended users, namely agricultural extension personnel and resource-poor farmers. The extent of adoption of the outputs in these countries is not known. In Botswana were the CPP projects were located, 200 farmers and about 50 extension personnel were directly exposed to the technology and a large proportion expressed the intention to use it.

*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)***

Over the four years of the CPP projects, contact was established with extensionists and researchers attempting to manage pest ABC in several countries neighbouring Botswana. Representatives from Namibia, Angola, Zambia, Botswana, Zimbabwe, Malawi, Tanzania, Mozambique, South Africa were brought together at an ABC symposium held as part of the biennial congress of the Entomological Society of Southern Africa, held at University of Pretoria, 6-9th July 2003.

A representative was invited from each country to present a country paper addressing a specified range of topics. Six further research papers presented the findings of the present project, with ample time for questions between talks. The symposium culminated in a wide-ranging general discussion held at the end of the talks, lasting for almost an hour. The symposium was attended by an audience of approximately 60. Thus information about ABC and the solutions proposed were disseminated widely throughout the region but outside Botswana the extent of uptake is not known.

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

In Botswana, there has been strong involvement of extension workers and farmers and a very positive reaction was received from 200 farmers + 50 extension staff who attended a national ABC demonstration and training day. The great majority (56/60) of farmers interviewed wanted to test out this ABC control method during the next outbreak. The scale of actual use is not known but the sporadic nature of the pest means that usage of the technology will not be apparent until an ABC outbreak occurs.

*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).***

Departments of Agriculture in the affected countries have been willing to participate and have played an important role. There has been strong cooperation by the Botswana Ministry of Agriculture in particular. The ARC and University of Pretoria have been active and enthusiastic project partners. ICIPE has played an important role in farmer surveys and output dissemination.

The chief Botswana collaborator strongly supports the promotion of the outputs. In his PhD thesis, Mosupi (2003)

argued that the most effective ABC management strategy during outbreaks in Botswana should be for farmers to implement the baited trench at field edge locations where ABC nymph populations build up prior to crop heading, i.e. before the invasion of the crop fields by ABC, and for the extension services to implement barrier spraying with fipronil in situations where the build up of ABC was too sudden to predict.

At the practical level of implementing the outputs, decisions appropriate to specific local situations need to be made about who is responsible for implementing ABC control – the extension services or the farmers themselves. In Botswana, more than in some countries in the region, the government has in the past taken much of the responsibility for pest control. During the farmer survey some expressed regret that the effect of this has been to reduce the community's sense of self-reliance and indeed willingness to take responsibility for pest control measure themselves. Participatory decision-making by the relevant stakeholders is required, followed by appropriate capacity building to provide the equipment and expertise necessary to spray the fipronil barriers and/ or dig and bait the trenches. The problem is exacerbated because both barrier spraying and trench digging have to be done within a very narrow time window, creating a sharp peak in demand for labour and equipment. It is likely therefore that even in Botswana, centrally organised services would not be able to meet demand. Enhancement of community's own willingness and capacity to control ABC is probably a key component of future technology adoption.

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.

It has sometimes been the practice of extension services to spray entire crops to control ABC. The new approaches proposed drastically reduce pesticide coverage as well as targeting the chemicals in such a way that non-target species are less affected. The approaches proposed are probably the least environmentally damaging of options which involve insecticides. A general increase in awareness and skill to identify an ABC problem means that less unnecessary pesticide use is likely to occur.

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

The baited trench did not attract vertebrate scavengers. An impact assessment carried out previously (Mosupi 2003) suggested that the baited trench had little effect on non-target invertebrates. However, in the Shoshong trail certain non-target invertebrates were definitely affected. Most, if not all, of the trenches trapped numerous large, flightless carabid beetles (Anthia sp.) and also large, flightless tenebrionid beetles (unidentified). These fell into the trench, were unable to climb out again, and subsequently they perished. Trenches may pose a hazard to

livestock, farmers being worried that they may fall into the trenches, though this never actually happened.

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)***

Climate change has caused increased climatic variability in sub-Saharan Africa and this will probably worsen. This makes the production of crops by subsistence farmers more and more precarious and unpredictable. Sporadic outbreak pests like ABC constitute yet another source of uncertainty in the production of a viable crop. Effective ABC control helps to offset the increasing yield unpredictability caused by climate change.

Annex

References

Green, S.V., Mosupi, P.O.P., and Mviha, P.J.Z. (2000) Is there a solution to the Setotojane (armoured bush cricket) problem? Agrinews (March): 9-13.
Matsaert, H., Mosupi, P.O.P., Mviha, P.J.Z., Green, S.V., and Minja, E. (2000) Survey of farmers' indigenous knowledge and control practices against armoured bush crickets (*Setotojane*) in Central and Francistown agricultural regions of Botswana. Setotojane-ABC Project, Dept. of Agricultural Research, Private Bag 0033, Gaborone, Botswana. 21pp.
Mosupi, P.O.P. (2001a) We can defeat SETOTOJANE. Department of Agricultural Research, Gaborone. 7pp.
Mosupi, P.O.P. (2001b) What can we do about Setotojane? Radio interview recorded Jan 2001 (date and time not known). 15 minutes. Broadcast twice in 2003. Botswana National Radio, in Setswana.
Mosupi, P.O.P. (2003) Chemical and cultural control of armoured bush cricket, *Acanthoplus discoidalis* (Walker) (Orthoptera: Tetigoniidae: Hetrodinae), in sorghum. PhD thesis, University of Pretoria. 156pp.
Wohlleber, B. (1996) First results of research on the armoured bush cricket (Acanthoplus discoidalis) on pearl millet in Namibia: population dynamics, biology and control. Pages 163-172 in: Drought-tolerant crops for southern Africa: proceedings of the SADC/ICRISAT regional sorghum and millet workshop, 25-29 July, 1994, Gaborone, Botswana (Leuschner, K. and Manthe, C.S., eds.). Patancheru 602 324, Andhra Predesh, India: ICRISAT.
Wohlleber, B. (2000) Research on armoured bush cricket (*Acanthoplus discoidalis*) management on pearl millet in Namibia. Pages 63-81 in: Proceedings of the workshop on management of sorghum and pearl millet pests in the SADC region, 10-13 February 1998, Matopos Research Station, Zimbabwe (Minja, E.M. and van den Berg, J., eds.). PO Box 776, Bulawayo, Zimbabwe: ICRISAT. (Semi-formal publication.)
