

CAPACITY BUILDING IN NEMATOTOLOGY IN EASTERN AND SOUTHERN AFRICA



Annual Report 2005-2006

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Gatsby Foundation Nematology Course Structure

SUMMARY OF ACHIEVEMENTS

In the first year of the project the following progress has been achieved:

- Seven nematologists from Kenya, Malawi, Tanzania, Uganda and Zimbabwe attended a 6-week training course to update nematological, statistical and presentational skills and expertise. These individuals will form the founder core group of the Nematode Initiative in Eastern and Southern Africa (NIESA).
- Six laboratories in the participating countries were equipped for nematological research and the diagnosis of soil nematodes of economic and ecological significance.
- Three collaborative research projects have been established between scientists in Kenya and Uganda and the UK, which involve the training of students from Malawi and Tanzania for PhD degrees.
- Three students have attended the one-year MSc course in Tropical Agriculture Development at the University of Reading in the UK and will conduct research projects there and at CABI Bioscience and Rothamsted Research.
- An interactive website (<http://www.africannematology.info/index.asp>) has been established to provide access to the major nematological journals and to exchange information between NIESA scientists. The site has a public area with general information to raise awareness of nematode problems in the region.
- A nematological Training Manual, produced by NIESA is near to completion and will be made publicly available on the website. A publicity leaflet to highlight the activities of NIESA has also been produced.
- Two meetings of NIESA scientists have taken place, the first at the International Livestock Research Institute, Nairobi, Kenya in August 2005 and the second in Kampala, Uganda in March, 2006 to determine research priorities and coordinate activities and to develop a long-term strategy for NIESA.

INTRODUCTION

The need to build capacity in plant nematology

Food security in Eastern and Southern Africa is of great concern in view of the increased incidence of drought-related crop failures. Crop losses due to pests and diseases and poor soil fertility also reduce crop production. Nematodes, particularly root-knot nematodes, *Meloidogyne* spp., are widespread and in developed agriculture cause 12% yield losses despite control measures. However, in many parts of Africa they may account for up to 70% crop losses, as growers are often unaware of the cause of plant damage or because control measures are not available. Increasing pressure on land resources and intensive cropping increase nematode infestations and adversely affect the sustainability of smallholder farmers. Most extension workers and researchers are able to recognise commonly occurring insect pests and diseases. However, symptoms caused by plant parasitic nematodes are rarely correctly attributed as they are either cryptic or may be mistaken for nutrient deficiencies and soil compaction..

Several methods of nematode management are available (Table 1) but most methods appropriate for resource poor growers provide < 90% control and must be combined to prevent significant yield losses. ***Sustainable methods of nematode management require local evaluation by trained scientists and trained support for growers.***

Table 1 Potential control of nematodes using different management methods

Method	Control achieved (%)
Exclusion	100
Resistant cultivar	90
Fumigation	90
Flooding	90
Resistant GM crop	75
Later cropping	75
Biofumigation	75
Trap cropping	60
Biological control	60
Solarisation	50
Root removal	50
Antagonistic crop	45
Bare fallow	35
Organic amendments	35
Tillage	18

The Nematode Initiative in Eastern and Southern Africa (NIESA)

NIESA aims to fulfil the demand for a network of well-trained nematologists who are equipped to carry out scientific research that will have practical benefits for local communities. The network will provide much needed training in nematology and provide support for other nematologists in the region.

The mission of NIESA is to **build capacity in nematology in Eastern and Southern Africa and to develop sustainable management systems for root-knot nematodes in the region.**

The specific objectives of the initiative are to:

- Initiate collaborative research aimed at developing scientifically sound and practical options for nematode management.
- Raise awareness of the need to manage nematodes among farmers, scientists involved in crop protection research and extension, and industry. This will be achieved through holding awareness workshops and through presentations at annual research review meetings for government research institutes, growers meetings and similar forums.
- Facilitate the pooling of existing information and technical skills in nematology within the region.
- Ensure transfer of research findings to end users.

This report presents progress after the first 12 months of activities and discusses future activities aimed at the promotion of NIESA amongst the scientific community.

ACTIVITIES

1. Training

First Gatsby Foundation Nematology Training Course

In July 2005, the projects first regional training course was held at the International Livestock Research Institute (ILRI) in Nairobi. This was a 6 week residential course with the purpose to provide specialised training in nematology and selected generic skills for the core group of scientists who will serve as trainers in subsequent courses. Lecturers in the course included the UK project partners; Dr David Hunt (CABI Bioscience), Dr Simon Gowen (The University of Reading) and Prof Brian Kerry (Rothamsted Research), together with Dr Parin Kurji (University of Nairobi) and Dr David Cooke (David Cooke Training, UK). Details of the course structure are provided in Annex 1.

A comprehensive manual was provided for identification of key nematode taxa, which will undoubtedly become a useful source of future reference for the trainees. A 2 day Natural Resources International –DFID –Crop Protection Programme workshop on biological control of root-knot nematodes, held during the training course, provided a unique opportunity for members of NIESA to interact with stakeholders from industry, producers seeking solutions to their nematode problems and other researchers in the field of crop protection. Links will be developed through this interaction that will

increase awareness of nematode problems and foster support from industry and relevant government ministries.

The statistics course dealt primarily with the use of EXCEL and GENSTAT for analysis of research data. An understanding of the implications of experimental design and options available for analysis of data will contribute significantly towards improving the quality of research carried out and ensure accurate interpretation and maximum benefits from research results.

Participants were offered a 3 month trial for GENSTAT version 8. Following the trial period a request was made for assistance to acquire the package through VSN for use by collaborating institutes. It is hoped that financial assistance will be received to purchase this software.

The last week of the course covered writing and presentation skills. Members of NIESA are encouraged to publish their research findings in international peer refereed journals and to present their results at regional or international symposia. This training assisted them to prepare quality reports and scientific publications.



Fig. 1. The first participants of the NIESA Training Course (back row: Dr Herbert Talwana, Mr Cornel Massawe and Dr John Kimenju; front row: Dr Waceke Wanjohi, Ms Nessie Lambano, Dr Zibusisu Sibanda and Mr David Kamangira) with Simon Gowen, Brian Kerry and David Hunt (inset), the nematology lecturers.

Participant feedback on the training course

The first training course had a mixture of experienced nematologists and graduate students and, although the nematological information was of general benefit to the latter group, and provided a useful update on research directions in applied nematology, other parts were considered to be too repetitive for the more senior participants. The course provided an excellent opportunity for interactions amongst the participants and facilitated the establishment the core group and discussions on the development of collaborative projects. The training in nematode taxonomy and

presentational skills were recognized by all as being particularly useful. The training in statistics provided by BUCS from the University of Nairobi involved too many individuals and was not focused. In general, participants felt that they were receiving adequate statistical support from their own organizations and there were few added benefits from a more centralised provision. The six-week course was a long time for the senior scientists to be away from their labs. In future, courses provided by NIESA would involve larger groups of less experienced nematologists and would be more narrowly focused, run for 4 weeks and involve field visits to see nematode damage on crops.

Post Graduate Training

Three graduates working in government research stations in Tanzania and Malawi were identified by their ministries for further training in nematology. The students registered for a 1 year MSc course in Tropical Agriculture Development at the University of Reading in September 2005 in preparation for their registration for PhD degrees at the Universities of Makerere, Nairobi and Kenyatta. The research projects which the students will be required to carry out in partial fulfillment of their degree programmes will be linked to research being carried out by their postdoctoral supervisors in East Africa, thus ensuring relevance of the projects to local situations, and will be completed at the University of Reading, CABI Bioscience and Rothamsted Research in the UK. During their training the students will be exposed to specialised techniques for working with biological control agents which will be put to use on the collaborative research projects that have been initiated, part of which will provide the research for their PhD projects

2. Research activities

For the past 5 decades, the primary tool for managing nematodes has been the use of nematicides. These products are highly toxic, can be prohibitively expensive, and are not appropriate for small holder farmers in the region. There is an urgent need to develop environmentally sound management systems to replace nematicides while maintaining high crop yields. Collaborative research projects that have been initiated were designed to meet the needs of the local community. Results obtained from the projects should contribute towards the development of a practical sustainable management system for nematodes. These results will be disseminated to end users and their uptake will be measured through a socio-economic analysis at the conclusion of the project.

Root-knot nematodes (*Meloidogyne* spp.) are major pests on vegetable and flower crops grown for local use and for export. Soil fumigants such as methyl bromide, already banned in northern agriculture, are used to control these pests in such high value crops. The development of sustainable methods of nematode management target root-knot nematodes in horticulture were chosen because such high-value crops provide a number of opportunities for intervention with control measures. Also, quality standards demanded by European markets demand reductions in the use of nematicides and the application of other control measures. The initial collaborative research conducted by NIESA scientists involves three projects that target root-knot nematode control in vegetable crops evaluating potential biological control agents and other measures and assessing the impact of these measures on nematode communities in soil.

A. The use of *Pasteuria penetrans* in an appropriate cropping strategy with non or poor host crops for root-knot nematodes.

Collaborating institutes: Bvumbwe Research Station, Malawi
Makerere University, Uganda
University of Reading, UK

Participating scientists: Mr David Kamangira – post graduate student
Dr Herbert Talwana – Local supervisor
Dr Simon Gowen – UK supervisor

Hypothesis tested: Selected local strains of the bacterium, *Pasteuria penetrans* can be mass produced and added to soil to provide biological control of root-knot nematodes in different crop sequences.

Progress: A limited survey has been conducted in Uganda and local strains of *Pasteuria penetrans* have been isolated. As part of the MSc project, David Kamangira will characterize these strains and compare them with those held in collections in the UK. Dr Herbert Talwana the supervisor of the project in Uganda will visit the UK in 2006 to learn a range of routine techniques for research.

B. Optimisation of the use of *Pochonia chlamydosporia* for the management of root-knot nematodes on vegetable crops in East and Southern Africa

Collaborating institutes: Department of Research and Development,
Ministry of Agriculture and Food Security, Tanzania
University of Nairobi, Kenya
Rothamsted Research, UK

Participating scientists: Mrs Nessie Luambano – post graduate student
Dr John Kimenju – local supervisor
Prof Brian Kerry – UK supervisor

Hypothesis tested: Selected biotypes of *Pochonia chlamydosporia* in combination with crop rotation and the use of organic soil amendments will provide sustainable management of root-knot nematodes in horticultural crops.

Progress: Unlike *P. penetrans*, the fungus *Pochonia chlamydosporia* is a facultative parasite, which grows readily *in vitro* and can be produced in quantities suitable for small-scale field applications. After a decade of research collaboration between Rothamsted Research and the Centro Nacional de Sanidad Agropecuaria in Havana, the fungus has been developed as a biological control product Klamic®, which is being registered in Cuba. In 2004, this technology was transferred to Dudutech K. Ltd., Naivasha, Kenya who have agreed to provide standard, high quality inoculum for the NEISA projects conducted in Kenya. In the UK, Nessie Luambano will test a range of soil amendments on the abundance of *P. chlamydosporia* in soil and its activity against root-knot nematode eggs.

C. Effect of management practices on nematode communities

Collaborating institutes: Department of Research and Development,
Ministry of Agriculture and Food Security, Tanzania
Kenyatta University, Kenya
CABI Bioscience, UK

Participating scientists: Mr Cornel Massawe – post graduate student
 Dr Waceke Wanjohi – local supervisor
 Dr David Hunt – UK supervisor

Hypothesis tested: The use of biological control agents and soil amendments have less impact on nematode communities than cropping sequences and nematicides and do not lead to the emergence of new pest species.

Progress: Soil samples have been collected from undisturbed and disturbed sites within vegetable growing areas in Kenya where future collaborative work will be centered. The abundance and structure of the nematode communities in these samples and those from different fields and semi-natural habitats in UK agro-ecosystems will be compared. This will provide Cornel Massawe with the skills to identify a wide range of soil nematodes and provide added diagnostic expertise within NIESA. For the PhD project he will work with his supervisors studying the impacts on nematode communities of the treatments applied to manage root-knot nematodes in Project 2 above.

3. Website development

An outline of the web site was included in the project proposal and it was considered vital that NIESA be involved in its development. In preparation for the development of the web site Dr Carol Steel at CABI Publishing circulated a questionnaire to members of NIESA in November 2005. The first prototype (Prototype A), which incorporated feedback on the questionnaire circulated to NIESA participants, was released at the end of January. This included the basic design covering the General Public Area and Members Area with Image Library, Discussion Board, and Member Access functionality. Prof Kerry has put together information on biological control of nematodes for the public area and members of NIESA have been asked to provide introductory texts for various sections, and pictures to load onto the image library. Work on prototype B which includes the remote updating system and links to selected journals and related web sites was released at the end of March (<http://www.africannematology.info/index.asp>), which includes documentation and training for updating of the website.

PROMOTIONAL ACTIVITIES

Publications

- An illustrated leaflet has been produced by participants in the training course to inform policy makers, funding agencies and interested individuals/organizations about the mission of NIESA and its relevance to nematological problems in the area.
- A Training Manual is being written that contains much information on nematode diagnosis, on handling methods and on the management of nematode pests. This manual will be available on the public-access area of the website.
- An article was written describing the aims and activities of NIESA, for the Newsletter of the Nematological Society of Southern Africa which is the principal learned society for nematologists in Africa. This article initiated a

requested from Prof Dirk de Waele at the University of Leuven, Belgium for NIESA to link with activities that he is involved in with ARC scientists in South Africa.

Invited presentations

Dr Sibanda was invited to give a short presentation at a monthly meeting for the NGO and donor community (including FAO) in Harare on 30 March. Most donors and staff in NGOs associate the need to control nematodes with the production of tobacco. This talk highlighted the effect of nematodes on other crops, particularly horticultural crops grown by smallholder farmers with whom the donor communities are greatly involved.

Dr Herbert Talwana has been invited to give a presentation at the European Society of Nematologists at their biennial meeting in Bulgaria in June 2006.

Prof Brian Kerry was invited to contribute to the British Association of Science meeting in Dublin in October 2005 and has been invited to give a similar presentation at the European Federation of Plant Pathologists meeting in Copenhagen, Denmark in August, 2006.

FUTURE ACTIVITIES

1. Diagnostics Services

The lack of taxonomic information and expertise in East and Southern Africa has been acknowledged by scientists, commodity groups and some government institutes. It is essential for scientists to accurately identify nematode groups of economic importance in order to provide a diagnostic service for farmers and design relevant research projects that address these problems and yield useful results for local communities. Plant inspectors also need this expertise in order to carry out their duties in preventing the entry of exotic nematode pests into the country. The shortage of well-trained taxonomists therefore has a big impact on the development of sustainable nematode management strategies and in reducing crop losses due to nematode infestations.

In order to address this deficiency in knowledge, NIESA will provide diagnostic support for countries in Eastern and Southern Africa. These services will essentially be web based and will carry out identification of nematodes in soil and plant material through the six nematology laboratories that have been set up in the region.

NIESA will provide expert underpinning of organizations whose mandate it is to provide diagnostic services in the region.

The main purposes of the diagnostic services are to:

- Maintain a database of nematodes identified in the region, their association with crops and damage symptoms.
- Maintain a reference slide collection for use by scientists in the region.
- Provide a library of digital images to assist with nematode diagnosis.
- Provide training through specific workshops held in the region.

A list of nematodes found in association with crops in Zimbabwe is being compiled from data collected over the past 18 years. This will be useful source of reference for the diagnostic centre.

Diagnostic methods

Currently classical methods of identification using morphological characteristics and host range tests are being used. The use of molecular methods for nematode identification such as real-time PCR (Polymerase Chain Reaction) and Enzyme Linked Immunosorbent Assays (ELISA) are being investigated. The Scientific Industrial Research and Development Centre (SIRDC) in Zimbabwe was established in 2003 for the purpose of transferring technology to Zimbabwe and regional stakeholders. Products from years of research are being commercialized and made available to end users. The organization has well-equipped laboratories that could support molecular identification of nematodes. Dr Sibanda has met with Dr E Khosa, the Director of Biotechnology Research at SIRDC to discuss cooperation between NIESA and SIRDC in providing a molecular identification service for nematodes. SIRDC has well trained microbiologists on their staff who could assist with molecular identification of nematodes.

2. Plant Inspectors' Workshop

The ability of plant inspectors to identify and manage quarantine pests has major implications for the successful implementation of sanitary and phytosanitary measures and on reducing crop losses due to pests and diseases. Good legislation and documentation procedures will be ineffective unless officers on the ground have the technical skills required to accurately identify pests and diseases.

NIESA, in collaboration with the Plant Protection Research Institute under the Department of Agricultural Research and Extension in Zimbabwe, have prepared a proposal to hold a workshop for plant inspectors from countries represented in NIESA. The main aim of the workshop is to train plant inspectors to identify pests of quarantine importance in the region in order to prevent entry of exotic pests and diseases and stop further spread of already existing pests and diseases that are currently limited in distribution. A list of quarantine pests for the SADC (Southern Africa Development Community) region has recently been updated. This list will be made available to workshop participants and a proposal will be made to compile a combined quarantine list for Eastern and Southern Africa. Workshop participants will also be provided with pest data sheets and posters to assist in identification of quarantine pests and diseases.

A proposal requesting funding for the workshop has been submitted to the FAO office in Zimbabwe and to COMESA (Common Market for East and Southern Africa) in Lusaka Zambia. Dr Z Sibanda has subsequently met with the FAO Agricultural Advisor in Harare to discuss this proposal. No response has been received from COMESA yet.

It has been proposed that the workshop be held in Harare, Zimbabwe in August or September of this year and it is hoped that FAO or COMESA will have responded to the request for financial assistance by then.

3. Second Training Course

Funds are available in the third year of the project to hold a second regional nematology training course. Core members of NIESA who benefited from training in the first course will lecture on this course. Although the content and format of the second course will be similar to the first one, sections of the training will be modified to enable scientists with little previous training or experience in nematology to benefit from the course. Field trips to examine nematode infected crops and practical classes in the diagnosis and quantification of nematode pests will be more extensive than in the first course which was aimed at more experienced nematologists. The taxonomy section will be more condensed to cover only key nematode species that scientists in the region are likely to encounter during the course of their research and diagnostic activities. Writing of project proposals for funding will also be included in the training.

Participants from universities and agricultural research stations will be invited to attend. Commodity groups, crop consultants and industry will also be encouraged to send representatives and to pay for their training. It is anticipated that about 30 participants will apply to participate in the course. Some funds will be made available from the existing budget to provide up to five competitive fellowships for participants wanting to develop careers as full time nematologists and to join the core group of NIESA.

4. Potential collaborations

SIRDC is very keen to work with NIESA. They have requested NIESA to prepare a formal proposal / concept note outlining areas of cooperation sought and expectations of the project. Possible collaboration in the following areas was discussed: Diagnostic services, production of biopesticides and training. One of the scientists at the Biotechnology Research Institute completed his BSc in 2004 and studied the efficiency of *Pochonia chlamydosporia* as a biological control agent for the root-knot nematode *Meloidogyne javanica*. His experience in working with this agent could be valuable in the collaborative trials that have been set up in the project.

Dr Luciano Rovesti, Biorational Development Manager, Dudutech K. Ltd., who attended the Workshop held during the training course at ILRI, is keen to be linked with the activities of NIESA and will provide standardised inoculum of biological control agents for field evaluation. Any evaluation of new agents, such as *P. chlamydosporia* and *P. penetrans* conducted by NIESA scientists should include comparison with products such as Bioact® developed by other companies and already on the market.

Prof Dirk de Waele from the Catholic University of Leuven, Belgium coordinates a project with several groups in South Africa entitled: 'Mobilising participatory ICM (Integrated Crop Management) for sustainable nematode management in household and community gardens of resource-poor farmers in South Africa'. This group is keen to link with the activities of NIESA and share information. All of the NIESA core group will become members of the Nematology Society of Southern Africa and will promote links between the two regions.

List of nematologists in East and Southern Africa

KENYA

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(Names **in bold** are of individuals within the NIESA core group)

ANNEXE 1

GATSBY FOUNDATION NEMATOLOGY COURSE STRUCTURE

11 July – 13 August 2005

Daily Sessions

A	9.00 am – 11.00 am
B	11.30 am – 12.30 pm
C	2.00 pm – 3.00 pm
D	3.30 pm – 5.00 pm

Weeks 1-2	David Hunt (DJH)
Weeks 3-4	Brian Kerry (BRK) / Simon Gowen (SRG)
Week 5	Parin Kurji (PK)
Week 6	David Cooke (DC)

Week 1

11 July	A	Introduction and methodology
	B	Methodology
	C	Practical
	D	Practical
12 July	A	Methodology
	B	Practical
	C	Practical
	D	Practical
13 July	A	General morphology/diagnostics
	B	General morphology/diagnostics
	C	Practical
	D	Practical
14 July	A	Tylenchida 1: Systematics/Tylenchoidea
	B	Practical
	C	Practical
	D	Practical
15 July	A	Tylenchida 2: Hololaimidae/Anguinae
	B	Practical
	C	Practical
	D	Practical

Week 2

18 July	A	Tylenchida 3: Pratylenchidae/Aphelenchoididae
	B	Practical
	C	Practical
	D	Practical
19 July	A	Tylenchida 4: Meloidogynidae/Criconeematidae
	B	Practical
	C	Practical
	D	Practical

20 July	A	Longidoridae/Trichodoridae	
	B	General morphology	
	C	Practical	
	D	Practical	
21 July	A	Practical	
	B	Entomopathogenic nematodes	
	C	Practical	
	D	Practical	
22 July	A	Synthesis	
	B	Synthesis	
	C	Assessment	
	D	Assessment	
Week 3			
25 July	A	Principles of nematode management	(BRK)
	B	Population dynamics/DCSS/Precision agriculture	(BRK)
	C	Nematode symptomatology	(SRG)
	D	Journal club	
26 July	A	Plant resistance and tolerance	(SRG)
	B	Managing resistance	(SRG/BRK)
	C	GM approaches for novel resistance	(BRK)
	D	Journal club	
27 July	A	Quarantine and pest exclusion	(SRG)
	B	Physical methods	(SRG)
	C	Cultural control	(BRK)
	D	Journal club	
28 July	A	Chemical control	(SRG)
	B	Interactions with other organisms	(BRK)
	C	Nematodes in soil ecology	(BRK)
	D	Journal club	
29 July	A	Entomopathogenic nematodes	(SRG)
	B	Entomopathogenic nematodes	(SRG)
	C	Practical on EPNs	(SRG)
	D	Writing an advisory leaflet	(SRG/BRK)
Week 4			
1 Aug	A	Principles of biological control	(BRK)
	B	Developing a control agent	(BRK)
	C	Practical on biocontrol agents	(SRG/BRK)
	D	Writing a note for policy makers	(SRG/BRK)
2 Aug	A	Biomanagement of nematodes with fungi	(BRK)
	B	Biomanagement of nematodes with bacteria	(SRG)
	C	Visit to Dudutech (Cancelled)	
3 Aug	A	} IPM in bananas	(SRG)
	B		
	C		
4 Aug	A	} NRI-CPP Workshop on biological control of	
	B		

- C } root-knot nematodes on vegetable crops
D
- 5 Aug A
B } NRI-CPP Workshop on biological control of
C } root-knot nematodes on vegetable crops
D
- Week 5**
- 8 Aug A Excel & introduction to GenStat - good statistics data management & descriptive
- 9 Aug A Excel & introduction to GenStat - good statistics data management & descriptive
- 10 Aug A Objectives of Study and planning the Analysis - this will include a brief discussion of Design
- 11 Aug A Analysis of Data
- 12 Aug A Interpretation and Dissemination of Results
- Week 6**
- 15 Aug Technical Writing
A Accuracy - avoiding grammatical errors
B Brevity - writing concisely
C Clarity - making your writing instantly understandable
D Style - improving your writing style
- 16 Aug A Writing a refereed paper. Preparation - choosing the journal, writing the outline
B Components of the paper - Introduction, Methods, Results, Discussion
C Components of the paper - Title, Abstract, Acknowledgements, References
D Editing and proof correcting
- 17 Aug Private Study Day
Time to prepare presentations for the next course or for one-to-one discussions on writing with the tutor
- 18 Aug Presentation Skills
A Preparation - advice on how to target and structure an effective talk
B First practice talks
C First practice talks
D Presentation - discussion on how to deliver your talk effectively
- 19 Aug A Visual Aids
B Second practice talks
C Second practice talks
D Concluding event and discussion