Registration for Biocontrol Agents in Kenya

Proceedings of the PCPB/KARI/DFID CPP Workshop

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The cover shows the neem tree leaf, a baculovirus and a ladybird beetle, representing possible biocontrol agents being offered by ‘protective’ hands to East Africa.

Benefits derived from the neem tree have been known for many years but in recent years the benefits of neem extracts as pest controllers have become more widely recognized in Africa.

The baculovirus *Autographa californica nucleopolyhedrovirus*, AcMNPV, visible only with high magnification electron micrography, is one of more than 600 baculoviruses isolated from arthropods (mainly insects), that has been successfully used for the control of certain pests.

The ladybird beetle represents natural enemies which can predate on or parasatize economically important insect pests.

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Proceedings of the Pest Control Products Board/Kenya Agricultural Research Institute/Department for International Development Crop Protection Programme Workshop
Nakuru, Kenya, 14–16 May 2003

Edited by

M.N. Wabule, P.N. Ngaruiya, F.K. Kimmins and P.J. Silverside

Production of this publication was funded by the DFID Crop Protection Programme. The views expressed are however not necessarily those of DFID.

Wabule, M.N., Ngaruiya, P.N., Kimmins, F.K. and Silverside, P.J. (2004) *Registration for Biocontrol Agents in Kenya, Proceedings of the Pest Control Products Board/Kenya Agricultural Research Institute/Department for International Development Crop Protection Programme Workshop, Nakuru, Kenya, 14–16 May 2003*. KARI/PCPB, Nairobi, Kenya, and Natural Resources International Ltd., Aylesford, UK. 230 pp. ISBN: 0-9546452-2-7

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Preface

For a long time, farmers in Kenya have relied heavily on chemical pesticides to control the different pests that continue to take a heavy toll on the country's predominantly agrarian economy. Generally, the practice has been justified by significant payoffs, despite its ruinous effects on beneficial, non-target organisms, human health and the environment. However, consumers of agricultural produce are becoming increasingly aware of the dangers engendered by the use of such chemicals and are demanding that certain minimum standards be met.

An upshot of this concern was the establishment, in 1994, of Maximum Residue Levels (MRLs) that exporters of horticultural produce must comply with. The requirement may necessitate non-use of certain chemicals if the produce is to be accepted for exportation. This scenario brings into stark focus the role of biopesticides as safer, environment-friendly and more affordable alternatives for controlling pests.

Research and development efforts in Africa and elsewhere have, for more than a decade, strived to develop biopesticides as well as promote their use in an effort to improve and sustain the livelihoods of the millions who depend on agriculture for a living, while minimizing the risks associated with the use of chemicals. A number of countries are already reaping the benefits of these efforts, but adoption and widespread use of biopesticide-based technologies in Kenya has been hampered by lack of supportive legislation.

The purpose of this workshop, therefore, was to discuss ways of formulating protocols that would facilitate amendment of the relevant legislation and thus enable fast registration of biopesticides, as a key step towards facilitating widespread use of this pest control alternative. The specific topics of these proceedings were organized under four main themes: Demand from the Horticultural Industry; Contribution of Research in Africa; Registration in Africa; and Registration in the Rest of the World. Stakeholders in various aspects of pesticide use, particularly those concerned with the export market, will certainly find the proceedings useful.

The workshop organizers acknowledge the Department for International Development, DFID, for financial support, the Director, Kenya Agricultural Research Institute, and the Secretary, Pest Control Products Board, for the valuable guidance and general support towards the organization of the workshop.

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Acknowledgements

The Workshop on Legislation of Biopesticides in Kenya was organized and planned by a team of experts from the Kenya Agricultural Research Institute, Pest Control Products Board, and Community Capacity Building Imitative. We therefore wish to acknowledge and thank the following members of the Workshop planning committee: Mrs Mary Wabule, Dr Lusike Wasila, Mr Gilbert Kibata, Dr Paul Ngaruiya, Dr Francis Nang'ayo, Mr Benson Kuria, Dr Maurice Odindo, Dr Robert Injairu and Mr Peter Opiyo. The secretarial assistance of Ms Mercy Imanene and Ms Nancy Gikonoyo before and during the Workshop is gratefully acknowledged and Ms Rubina Adhiambo was key in formatting the manuscripts for the meeting and preparation of the illustrations. A team of scientists from the Crop Protection Programme, including Dr Frances Kimmins and Dr Nicola Spence, participated fully in the preparatory phase of the Workshop.

The Workshop on Legislation of Biopesticides in Kenya was made possible through funds from the Department of International Development's (DFID) Crop Protection Programme to whom we are extremely grateful.

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Acronyms and Abbreviations

AAK	Agrochemicals Association of Kenya
AcMNPV	*Autographa californica multiple nuclear polyhedrovirus*
ACP	African, Caribbean and Pacific
ADI	acceptable daily intake
AELGA	Africa Emergency Locust and Grasshopper Assistance
AFLP	amplified fragment length polymorphism
AfMNPV	*Anagrapha falcifera multiple nuclear polyhedrovirus*
a.i.	active ingredient
a.s.	active substance
BCP	Biological Control Products, South Africa
BIS	Bureau of Indian Standards
Bt	*Bacillus thuringiensis*
CABI	CABI Bioscience, UK, a division of CAB International
CBD	Convention of Biological Diversity
CENATOX	National Toxicological Centre, Cuba
CENSA	Centro Nacional de Saindad Agropecuaria, Cuba (National Centre for Animal and Plant Health)
CGIAR	Consultative Group for International Agricultural Research
CICA	Centre for Environmental Inspection and Control, Cuba
CIDA	Canadian International Development Agency
CILSS	Interstate Committee for Drought Control in the Sahel
CITMA	Ministry of Science, Technology and the Environment, Cuba
CNSB	National Centre for Biological Safety, Cuba
CNSV	Central Register of Pesticides and External Quarantine Department of the National Plant Pathology Centre, Cuba
COMESA	Community of East African States
CPP	Crop Protection Programme
CPV	*cytoplasmic polyhedral virus*
CSP	Comité Sahelien des Pesticides (Sahelian Pesticide Committee)
DAR	Draft Assessment Report
DEET	diethyltoluamide
DFID	Department for International Development, UK
DFPV	Programme Majeure Formation, Protection des Végétaux
DGIS	Directorate-General for International Cooperation, the Netherlands
DNV	*denso virus*
DOAE	Department of Agricultural Enterprises, Thailand
EC	emulsifiable concentrate
EFSA	European Food Safety Authority
EMPRES	Emergency Prevention Service (FAO)
EPA	Environmental Protection Agency (US)
EPV	*entomopox virus*

EU	European Union
EUREPGAP	Euro-Retailer Produce Working Group for Good Agricultural Practice
FAO	Food and Agriculture Organization of the United Nations
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FPEAK	Fresh Produce Exporters Association of Kenya
GLP	good laboratory practice
GM	genetically modified
GRAS	generally regarded as safe
GTZ	Deutsche Gesellchaft für Technische Zusammenarbeit, Germany
GV	*granulovirus*
HCDA	Horticultural Crops Development Authority
HPLC	high performance liquid chromatography
ICAR	Indian Council for Agricultural Research
ICIPE	International Centre of Insect Physiology and Ecology, Kenya
ICPM	Interim Commission of Phytosanitary Measures
IGR	insect growth regulators
IITA	International Institute of Tropical Agriculture, Benin
IOBC	International Organization for Biological Control
IP	intellectual property
IPM	integrated pest management
IPPC	International Plant Protection Convention
IPR	intellectual property rights
IRM	integrated resistance management
IU	international unit
IV	*iridio virus*
JKUAT	Jomo Kenyatta University of Agriculture and Technology, Kenya
KARI	Kenya Agricultural Research Institute
KEMRI	Kenya Medical Research Institute
KEPHIS	Kenya Plant Health Inspectorate Service
KIPI	Kenya Industrial Property Institute
KSh	Kenya shilling
KSTCIE	Kenya Standing Technical Committee for Imports and Exports
LD_{50}	mean lethal dose
LGP	laboratory good practice
LOD	limit of detection
MINAGRI	Ministry of Agriculture, Cuba
MINSAP	Ministry of Public Health, Cuba
MNPV	multiple nuclear polyhedrovirus (and see NPV below)
MRLs	maximum residue levels
MTAs	Material Transfer Agreements
MTP	medium term plan
NGO	non-governmental organizations
NPV	nucleopolyhedrovirus (also nuclear polyhedrosis virus)

OAU	Organization for African Unity
OB	occlusion body
ODA	Overseas Development Administration (now DFID)
OECD	Organization for Economic Cooperation and Development
PCAK	Pesticide Chemicals Association of Kenya
PCPB	Pest Control Products Board, Kenya
PCR	polymerase chain reaction
PIPs	plant-incorporated protectants
POPs	persistent organic pollutants
PxGV	*Diamondback moth granulosis virus*
R&D	research and development
RMS	Rapporteur Member State
SCAH	Standing Committee on the Food Chain and Animal Health, EU
SDC	Swiss Development Corporation
SEARCH	South and East African Regional Committee on Harmonization
SME	small-medium enterprise
SNPV	single nuclear polyhedrovirus
ULV	ultra low volume
US EPA	United States Environmental Protection Agency
USAID	United States Agency for International Development
USDA/APHIS	United States Department of Agriculture/Animal and Plant Health Inspection Service
WHO	World Health Organization
WP	wettable powder

Opening Speech

Dr Ephrahim Mukisira
Deputy Director, Kenya Agricultural Research Institute (KARI) Headquarters
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The Director of Agriculture and Livestock Development, Distinguished Guests, Ladies and Gentlemen, I am delighted to be here among scientists and stakeholders whose common goal is to develop protocols for registration of biopesticides. As you are aware, biopesticides are pest management tools derived from natural resources that are an important component of the Integrated Pest Management (IPM) strategy. On-farm crop losses due to pests (insects, mites, diseases and weeds) are conservatively estimated at 33 per cent in most tropical developing countries. Further losses occur during harvesting, transportation and storage.

The Kenya Agricultural Research Institute (KARI) strategic plan for 2003–10 as well as the Third Medium Term Plan (MTP III) for the period 2003–08 stipulate clearly the institution's vision and mission to develop and disseminate appropriate technologies for the improvement of rural livelihoods and alleviation of poverty.

In pursuit of these goals KARI undertakes research to enhance food production through improvement of crop germplasm, production technologies and pest management in collaboration with several local and international research institutions.

While a great deal of research on pest management has been devoted to the evaluation of conventional chemical pesticides, the institute has been exploring other strategies including biotechnology.

Research on biopesticides has also advanced with the discovery of fungi, bacteria, viruses and nematodes capable of suppressing important insect pests of crops. Some of these products are at an advanced stage of development as potential biopesticides. Many of these will be reported by scientists from various research institutions during the workshop. KARI is therefore a stakeholder in this workshop that intends to formulate protocols for registration of biopesticides.

I hope during your deliberations you will also have an opportunity to address pertinent concerns relating to patents or intellectual property rights as well as conservation of our country's biodiversity. It is now my pleasure to invite the Director of Agriculture, Dr J.K. Wanjama, to deliver the keynote address.

Keynote Address – Biopesticides as Potential Tools for Pest Management

Dr Joseph K Wanjama
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Ladies and Gentlemen, it is my sincere pleasure to be here among you distinguished scientists, policy makers and stakeholders at the first Biopesticide Legislation Workshop. I take this opportunity to acknowledge your personal contribution by devoting your precious time to attend this forum. I also wish to thank all who have been involved in planning and providing material and logistic support to make this event possible in a very serene environment.

Some of you may clearly recall the revolution in pest management which was set in motion three and a half decades ago with the discovery of DDT in 1930. In quick succession there followed discoveries of other organochlorines, organophosphates, carbamates and more recently pyrethroids. These chemical pesticides became the main tools in pest management for public health, livestock and crop protection. These discoveries, coupled with improvements in application technologies, made it possible to precisely deliver fairly low concentrations of active ingredients to desired targets with spectacular and rapid suppression of pests.

However as the frontiers of scientific knowledge advanced the intrinsic capacity of the chemicals to kill pests was also found not to be entirely innocuous to other forms of life. The pesticides would also kill non-target organisms such as the beneficial arthropods (predators, parasitoids and pollinators), other invertebrates and vertebrates both in aquatic and terrestrial ecosystems. Some were extremely persistent organic pollutants (POPs) and would undergo bio-accumulation through the food chain. Their active ingredients and degradation metabolites were also found to impair mammalian endocrine systems, nervous systems and some were carcinogens – not to add that some were extremely efficient for intentional suicides. These concerns were raised by lobby groups and finally by legislators who initiated strict restriction on the use of chemical pesticides. Today the dossier required for registration of a chemical pesticide is massive and the related data are expensive to generate as it must adequately allay fears of potential risk to the users, consumers and the environment. An example of the changing scenario can be best drawn from the recent threats to our horticultural produce markets in Europe.

I believe that most of you here are aware of the huge European Union programme for harmonization of the maximum residue levels (MRLs) of pesticides permitted in agricultural produce which started in 1994. In the absence of accepted data on residues by pesticide/crop combinations, most of the conventional older pesticides have had their MRLs set at the limit of detection (LOD) or zero which implies that the pesticides are practically withdrawn or severely restricted from use on crops intended for export to the EU markets. A substantial quantity of horticultural produce originates from the African, Caribbean and Pacific (ACP) countries, which are also ideal havens for pests. The same countries are also subjected to strict phytosanitary and sanitary regulations

with regard to non-tolerance of pests or related damage in their produce. Here lies the dichotomy of interest at our export markets that now insist on pest free produce, which is also pesticide residue free.

Slightly over 92 per cent of our total exports is made up of horticultural produce which earns over KSh 14 billion annually (1998). Local consumption of horticultural produce amounts to 95 per cent of the total production. Horticulture is therefore a vital industry for Kenyans as it provides food, employment, agro-industries and badly needed foreign capital. While our concerns should include the safety of our local consumers our export markets are now under threat from the restricted use of conventional chemical or synthetic pesticides. Acceptable and effective alternative pest control strategies must be earnestly explored and adopted to save the horticultural industry. Biopesticides are therefore potential options for pest management if we could develop the appropriate criteria for their legislation and wider usage. My understanding of biopesticides is that they are derived from biological sources, exist in nature and are comparatively benign to the environment. However what is natural does not always translate to less risk to non-target organisms, vertebrates or humans. If they have the intrinsic ability to kill or suppress pests they also have the potential to suffer the same fate as that of chemical pesticides, such as development of pest resistance, concerns of consumer safety and environmental pollution. They may therefore not be accorded a clean bill of finding during registration but will be evaluated on the basis of robust science.

Ladies and Gentlemen, I am convinced that your collective experience and scientific knowledge will subscribe to the formulation of a blueprint, if not a comprehensive set of protocols, for legislation of biopesticides in order to utilize fully their potential in pest management. You may also wish to address other related issues of conservation of biodiversity, ownership, intellectual property rights, biopiracy, mass production and quality control. You are the experts and I leave this matter entirely to you.

I hope those visiting this game park for the first time will also take the opportunity to view some of our wild life.

It is now my pleasant duty to declare the Biopesticides Workshop officially open.

Thank you

Policy Role of Crop Protection Research – Using Research in Policy Making and Implementation

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The Department for International Development's Crop Protection Programme (DFID CPP) has commissioned demand-led research on the development of socially responsible and environmentally benign pest management methods since 1995. The identification and development of biopesticides have been major activities for the programme in Africa as well as in Asia and Latin America, but the programme also has an explicit responsibility to promote the uptake of research outputs to achieve outcomes, i.e. to improve livelihood security of poor people. The application of technologies such as biopesticides with minimal or no maximum residue level (MRL) risks in Kenya could potentially have positive impacts on the continued involvement of thousands of smallholders in the export horticulture sector, thus halting the rate of marginalization. Their application could also have indirect impacts on workers employed in the export sector as well as offering new opportunities for enterprise development. To facilitate the adoption of new biopesticides which have been identified we have been analysing successes and failures of earlier promotional projects. We are now aware that to prevent market failure, promotional research projects must, in addition to technology validation, consider the following issues:

1. Be relevant to policies and initiatives supporting technology uptake and agricultural reform **OR**
2. Provide evidence for decision making and policy support where inadequate information exists
3. Use effective information channels to key stakeholders
4. Broaden the horizons beyond Integrated Pest Management (IPM) projects by linking with other initiatives that can support a broader developmental framework
5. Encourage new partnerships for agricultural enterprise.

It is largely the second and fifth issues that the workshop participants will be addressing over the next three days. Researchers, policy shapers, consultants and industry representatives have been invited to present evidence on the effectiveness, application and registration of biopesticides from case studies based in Kenya, West Africa, India, Thailand, Cuba, EU and Organisation for Economic Cooperation and Development (OECD) countries. I am grateful to the experts for taking part in this endeavour and to our colleagues at Kenya Agricultural Research Institute (KARI) and the Pest Control Products Board (PCPB) for organizing the event, in particular Mrs Mary Wabule, Dr Lusike Wasilwa, Dr Paul Ngaruiya and Peter Opiyo. We hope that the evidence of the experts gathered here today will be captured and utilized to develop policies which will keep the Kenya horticulture sector vibrant, competitive and a key contributor to poverty alleviation.

Demand from Horticultural Industry

Problems Facing the Flower Industry

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KFC Position on Biopesticide Legislation

The flower industry is very valuable to the Kenyan economy:

- Over 100,000 jobs created directly and indirectly
- 50,000 tonnes of flower exported last year
- Although flower growers represent only 0.0003% of Kenyan arable land they have an annual turnover of US$130 million
- Kenya is largest exporter to the EU – 25%of market share
- Horticulture sub-sector is the 2nd largest foreign exchange earner for the Kenyan economy.

We need the support of the Kenyan Government if we are to maintain this enviable position in the EU market. Specifically the industry needs efficient biopesticide legislation to help it retain its market share.

Biopesticides, macrobial and microbial biological agents are important to the flower industry for several reasons:

Market Forces
Consumers in Europe are concerned about the amount of pesticides used in horticulture – especially with the possible negative impacts on the environment. Therefore growers are under pressure to reduce pesticide use. We anticipate a time when maximum residue levels (MRLs) may also be applied to ornamentals (as they are now in vegetables and fruits) and we stand to lose our markets if we cannot meet these demands. Since biocontrol of pests requires substantially more expertise and management, the industry wishes to have the opportunity to start learning about using these technologies as soon as possible. Kenya's main competitors already have access to these technologies and further delay could lead to loss of competitive advantage.

Health and Safety
The flower industry has received a lot of bad press regarding alleged excessive use of pesticides and the endangering of the health of flower farm employees. Civil society groups especially have waged a damaging campaign against the flower growers and we stand to lose our markets if we are not able to adopt biocontrol measures.

Re-Entry Intervals
The re-entry intervals set by the World Health Organization (WHO) for when it is safe to enter a greenhouse after spraying is finished are shown below:

WHO Class Ia	**RED LABEL**	**36 hours re-entry interval**
WHO Class Ib	**RED LABEL**	**18 hours re-entry interval**
WHO Class II	**YELLOW LABEL**	**12 hours re-entry interval**

WHO Class III	**BLUE LABEL**	**4 hours re-entry interval – or when leaves are dry**
WHO Class IV & V	**GREEN LABEL**	**4 hours re-entry interval – or when leaves are dry**

The high re-entry intervals (e.g. 36 hours for Class 1a chemicals) greatly interfere with the harvesting operations. However, using macrobial natural enemies has no re-entry intervals and hence harvesting can continue uninterrupted.

KFC Recommendations for Biopesticide Legislation

Enabling Environment
Friendly Legislation that encourages investment into the development of biocontrol is very important. We seek a partner in the regulatory institution – not a policeman.

Indigenous natural enemies are exempt from registration under international pest control acts

We do not see justification for Kenya veering away from this international standard.

Potential Conflict of Interest
The development and commercialization of this biotechnology will create opportunities and perceived threats to different groups in the market place. We would like appropriate checks and balances to be put in place so that parties with a vested interest are not able to unfairly influence the registration process.

Fast-tracking Registration
In the event that it is decided that any of the microbials, macrobials or botanical pesticides require registration, we suggest that the granting of temporary permits be considered so that the industry does not suffer long delays in access to these technologies. We understand that almost 50 per cent of the agrochemicals used in Kenya are on temporary registration – so there seems to be a precedent to allow for this.

Fear of Interception
There seems to be fear among some growers and exporters (whether unfounded or not) that consignments of flowers that have indigenous natural enemies may be impounded in the EU until the insects are identified, which could take three to seven days. This would be disastrous for flowers as the quality of the product would diminish substantially in this kind of time-period. Written confirmation from EU phytosanitary inspection institutions that consignments will not be intercepted or subjected to lengthy identification processes if natural enemies are present will go a long way in reassuring growers.

Problems Facing the Vegetable and Fruit Industry

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Industry Background

The vegetable and fruit industry is an important agricultural sector in Kenya. Currently the total production stands at 3,500,000 tonnes. Most of the produce is consumed locally, but a significant proportion is exported. The value and volume of exports has continued to rise over the years as shown in Table 1 and Figure 1. Total value of exports in 2002 was KSh 120 million and production was over 110,000 tonnes. Growth forecast for 2003–05 is 140,000 tonnes.

Table 1: Value of horticultural exports from 1997 to 2002, Kenya

	Value in Kenya shillings (millions)				
	1997	**1998**	**1999**	**2001**	**2002**
Flowers	35	31	38	41	52
Fruits	17	12	15	23	22
Vegetables	36	15	46	35	46

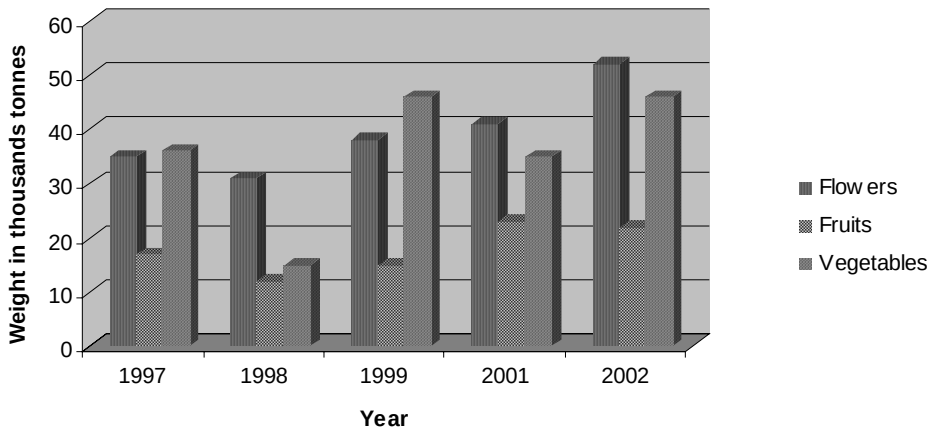

Figure 1 Production of horticultural exports in Kenya from 1997 to 2002

Sector's contribution to the economy:

- Increased food self sufficiency, food security, improved nutrition
- 2nd largest foreign exchange earner – in 2002 the industry earnedUS$300 million
- Employment creation to both the rural and urban population estimated at 500,000 and over 2 million directly and indirectly respectively.

Food Safety Called into Question

Public opinion is concerned about problems of the safety of foods. Serious crises have occurred in various sectors of European agriculture, amply relayed by the media. Consumers, extremely aware, expect the institutions to implement regulatory provisions ensuring optimal protection of their health and the business world to demonstrate that their practices are duly complying with the provisions.

The Governments of the EU member States and the European Commission have made the safety of food their priority. In so doing, they have:

- undertaken a review of the regulations dealing with pesticides maximum residue limits (MRLs) and authorized use of pesticides with the EU
- generalized the assessment systems for environmental and health risks linked to the use of chemical products
- strengthened controls at the food production stage, pursuing their audits into the supply chain in order to identify the origin of the misdemeanours observed.

Faced with new legal orientations the regulators have transferred the burden of proof to the private sector, and those who cannot prove that they have taken every possible precaution to avoid any contamination of the fruit and vegetables that they export and sell to consumers will have to be phased out of the supply chain. Further, those contravening EU regulations can be inflicted with heavy sanctions (two years of imprisonment and a fine of nearly US$40,000 per consignment).

For these reasons, European buyers are requiring of their suppliers every guarantee of traceability and the safety medical conformity of their fresh fruit and vegetables.

ACP-EU Horticultural System in Danger

In the face of the increased demands made of their suppliers by the European buyers, there are risks that the commercial links between the various players in the African, Caribbean and Pacific-European Union (ACP-EU) horticultural system will be severed. These risks are particularly great with regard to the residual pesticide thresholds (MRL) to be complied with, especially when these MRLs have been set at the detection threshold 'Limit of Detection' (LOD – the equivalent of analytical zero).

This means that no detectable trace of residue will be tolerated. The regulatory changes within the EU can seriously impact the Kenyan economy unless the safety conformity of the fruit and vegetable exported in the EU is demonstrated.

The exporters, who in order to prove the traceability and quality of their export-oriented produce, are going to restrict, even suspend, their suppliers from producers that do not adopt agricultural practices that conform, with the smallest being the most vulnerable.

While appreciating that the use of pesticides is indispensable for the great majority of tropical horticultural production, the industry faces the challenge of demonstrating conformity to set MRLs at every stage, in a coordinated and credible manner. This is why the subject of biopesticides has become so dear to us and we must now move from mere rhetoric and act. In this respect, this workshop could not have been timelier.

Problems

Food safety is being called into question, leading to MRLs being set in the EU. ACP-EU horticultural system is in danger and under pressure relating to usage of synthetic pesticides as well as social accountability for workers who come into contact with pesticides. Stakeholders and regulators are not being tuned to the use of biopesticides, while adjusting to change is slow. Enabling policies and systems need to be set up to facilitate the utilization of biopesticides.

The Way Forward

Immediate

- Knowledge and wisdom from unbiased players should be utilized in the use of biopesticides.
- Enabling policies and systems need to be set up to facilitate the utilization of biopesticides.
- Pest Control Products Board (PCPB) should allow the use of biocontrol agents on trial basis.

Medium to Long-term

- Awareness regarding economic and safety benefits of biopesticides to stakeholders should be intensified. This should cover both export and domestic horticulture.
- Strategies to export biopesticides to other countries, especially in the COMESA region, should be explored.

Discussion

Comment

The ability of biopesticides to support small-scale farmers and ensure secure production of staple food crops in Kenya (3,500,000 tonnes) has been confirmed by the Cubans. Cuba does not have an important horticultural export market but it has a substantial biopesticide industry which supports small-scale farmers and has reduced pesticide imports by 86%. Biopesticides are usually the most expensive type of pesticides in Europe but Cuba has developed policies and production systems that make them available and small-scale farmers. If the same reduction in pesticide imports were achieved in Kenya as in Cuba, this would be a possible annual waiving of £35 million pounds per year of foreign exchange.

Kenya horticultural exports account for US$300,000,000. The export market customers demand a reduction in pesticide use. In order to maintain (not to expand) on essential export market we must reduce; the Dutch Government some years ago set a national target to reduce pesticide use by 50% over five years. These targets have been met and pressure to reduce pesticides has continued in Europe.

Kenya horticultural industry needs the support of the Kenya Government in policy development to ensure reduction in pesticide use and continued contribution of the flower and vegetable industry to the Kenyan economy.

Comment
Only 3% of horticultural produce is exported and therefore there is a need to look at local consumption in the use of biopesticides and not just what is destined for the export market.

Response
FPEAK is interested in the high value export market as compared to the local low value market. However, this session should address the issue of use of biopesticides for produce meant for the local market.

Comment
Cuba has extensive use of biopesticides and their local production has benefited a lot. The use of biocontrol agents should be promoted locally.

Response
It is up to the committee to look into this issue. Import companies normally conduct audits on use of pesticides and therefore farmers cannot grow both for local market and for export market.

Comment
On the issue of resisting change, biopesticide companies should market as aggressively as agrochemical companies. However, research should be done on biopesticides. Such research should be prioritized by research institutions and stakeholders should help in formulating priorities.

Response
A national MRLs committee has been set up and one of the issues that it will address is the use of biopesticides.

Comment
The flower industry is very important to the economy and Dudutech is working with the industry to reduce pesticide use. There has been criticism by human rights bodies. Dudutech will spend US$800,000 in 2003 for development of biocontrol agents.

Comment
We are encouraging the use of biocontrol agents and we have contacted the UK regarding which biocontrol agents are acceptable, however, caution is being employed in the use of biocontrol agents. We will work closely with the EU to get a list of acceptable biocontrol agents.

Comment
There should be no fear of interception of produce because natural enemies are known. In the EU there is immediate identification of the natural enemies and therefore produce is not detained at the point of entry.

Commercial Opportunities for Biopesticides

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Introduction

The Agrochemicals Association of Kenya (AAK) is the national representative of the International Agrochem Industry represented worldwide by CropLife International (formerly GIFAP). AAK is, therefore, the umbrella organization in Kenya for manufacturers, formulators, re-packers, importers, distributors, farmers and users of pest control products (pesticides). The local association has existed under various names, with the most recent being Pesticide Chemicals Association of Kenya (PCAK), since 1958.

The Association, through an elected Executive Committee, runs the affairs of the Agrochemical Industry locally using the following objectives:

1. Promote public education concerning the use of pesticides safely
2. Provide an agency for liaison with Government and others, on all matters of mutual interest
3. Consider and deal with matters relating to customs duty, registration and labeling of pesticides, setting of standards in pesticides, following safety codes and promotion of the FAO Code of Conduct on distribution and sale of pesticides
4. Protect common trade interests of its members, where these are concerned with the manufacture, formulation and distribution of pesticides
5. Cooperate with all agencies seeking the improvement of Kenyan Agricultural and Pastoral Production and Environment
6. Encourage and promote just, fair and honorable practice, and oppose malpractice and illegal practices in the operation of the industry
7. Work with the Government towards the regulation and importation of pesticides
8. Encourage research in all areas that will improve the effective use of pesticides.

All these objectives of the Agrochemical Industry were put in place after the industry recognized that it has social and environmental responsibilities to the consumer, user/worker and environment in general in control of pesticides.

Management of the Association

Membership
Membership to the Association is open to those in the following categories:

a) Full Membership
Full membership of the Association shall be open to any person or organization in Kenya falling under any of the following:

i. Manufacturers of active ingredients used in the formulation of agricultural chemicals and related products
ii. Formulators contracted to manufacturers of active ingredients used in the formulation of agricultural chemicals and related products
iii. Contracted representatives of manufacturers of active ingredients used in the formulation of agricultural chemicals and related products not otherwise represented in Kenya
iv. Local manufacturers, formulators and re-packers of pesticides.

b) Associate Members
This shall be open to those persons or corporations involved in the distribution and/or usage of pesticides and related products originating from suppliers described under sub-paragraph (a) above or other sources registered with Pest Control Products Board.

c) Growers and Parastatals
This shall be open to any grower or farmer or parastatal engaged in agricultural production.

d) Non-Resident Membership
This shall be open to any manufacturer, trader or person who is not based in Kenya but is marketing pesticides through an appointed agent or agents.

The Executive Committee

a) The Executive Committee of AAK is responsible for the management of the Association. It is composed of the following:
- Chairman
- Vice-chairman
- Treasurer
- Assistant Treasurer
- 4 members representing full members
- 2 members representing associate members
- 2 co-opted members
- Secretary.

b) The Executive Committee operates through the following sub-committees:
i. Ethics and Government Liaison Sub-Committee
ii. Finance Sub-Committee
iii. Training Sub-Committee
iv. Environmental Sub-Committee
v. Publicity, Recruitment and Dealer Accreditation Sub-Committee
vi. Veterinary Sub-Committee.

c) Responsibilities of Sub-Committees
i) Ethics and Government Liaison Sub-Committee
- Maintains discipline among its members by enforcing the constitution and the code of practice
- Provides an agency for liaison with government and other agencies on all matters of mutual interest
- Deals with the registration and labeling requirements.

ii) Finance

- Looks after the finances of the Association, which will include budgeting and location of funds to various activities.

iii) Training

- Co-ordinates all training activities of the Association
- Promotes public education concerning the safe use of pesticides.
- Works closely with other organizations dealing with training.

iv) Environmental

Looks into:

- Packaging standards
- Obsolete stocks
- Pictograms and colour codes
- Transportation requirements of pesticides
- Poison centres and supply of antidote kits
- Protective clothing.

v) Publicity, Recruitment and Dealer Accreditation

Handles*:*

- Publicity of the Association's activities and those contravening the Pest Control Products Act and AAK Code of Conduct
- Recruitment of new members
- Accreditation of dealers, sales representative, transporters and all other people involved in pesticides.

vi) Veterinary Sub-Committee

Deals with:

- Co-ordination of all environmental matters of animal health products
- Development and co-ordination on the guidelines on training in animal health
- Any other matter that touches on animal health.

Commercial Opportunities for Biopesticides

The International Agrochemical Industry is made up of National Agrochemical Associations, Regional Associations and the International Association (which, in the case of Kenya, is made up of Agrochemicals Association of Kenya, CropLife Africa Middle East and CropLife International), and has the main object of promoting environmentally sound use of agricultural chemicals for the economic products of safe, high quality abundant food, fibres and other crops/livestock. This shows that the Agrochemical Industry has the responsibility of continuing to provide safe and effective products as far as the users, consumers and the environment are concerned. The industry must also promote the use of biopesticides, which play a role in the production of safe crop and livestock products.

A number of AAK member companies are already exploiting commercial opportunities existing in the Kenyan market. This has been necessitated by the new EU regulation of maximum residue levels (MRLs) which has made farmers go for appropriate pesticides in the critical windows within the production cycle.

The specific 'windows' within the crop production cycle are:

(i) Land preparation to planting
(ii) Planting to start of flowering
(iii) Start of flowering to start of harvesting
(iv) Start of harvesting to end of harvesting.

The synthetic pesticides should be used more towards the start of the cycle and biological pesticides towards the end.

Discussion

Question
What is the annual turnover of agrochemical sales in Kenya?

Answer
4,000,000,000 KSh/year

Question
What proportion of turnover can be attributed to biopesticides?

Answer
The figures were not known but were estimated at less than 2%.

Question
What work do AAK have to achieve their objectives?

Answer
AAK works through Ministry of Agriculture extension staff countrywide. AAK has also trained farmers, Ministry of Agriculture staff, etc.

Question
How does AAK strategically view the development of IPM since it inevitably leads to reduction in use and sales of pesticides?

Answer
AAK has been involved in 'safe use' of pesticide training for many years and already promotes IPM.

Question
Meeting your objective requires that you have an elaborate extension system, which as a small association you may not have. What linkages do you have with the public and/or private extension providers?

Answer
AAK will continue to work with partners in the agrochemical industry in Kenya.

Comment
The AAK presentation on share of biopesticides points to the need to have 'softer' regulations to promote biopesticides. It is appropriate to emphasize that biopesticides should be 'specially' encouraged as they have less market turnover per shilling invested.

Implementing IPM in Kenya: Products and Services

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Introduction

Dudutech is Kenya's first Integrated Pest Management (IPM) Company. It was inaugurated in May 2001, and is able to offer a full range of IPM products and services to the Kenya horticultural industry. Dudutech employs 90 staff, of whom 34 are Kenyan graduates working in natural enemy production (indigenous predators, parasitoids and entomopathogenic nematodes), microbiologists developing indigenous biopesticides (naturally occurring insect-specific diseases) and field staff undertaking IPM trials and developing advisory skills to support growers. It has a training department with three full-time staff, who run examined courses for small- and large-scale growers throughout the country in conventional pesticide use as well as unique crop specific IPM courses.

In the space of three years, Dudutech has developed IPM products and protocols which have enabled its sister company, Homegrown (K) Ltd., to eliminate completely the use of organophosphates, carbamates and organochlorines from its vegetable production. Dudutech is beginning an intensive programme aimed at doing the same thing in flower crops over the next two years. Homegrown is the largest horticultural export company in Kenya. The export market customers are demanding a reduction in pesticide use, whether it is on vegetable or flower crops. The EU legislation on pesticide maximum residue levels and the requirement for produce to company with EUREPGAP means that Kenya must adopt IPM in order simply to maintain its essential foreign exchange earnings from horticultural export sales. IPM is being developed in all other producer countries in Africa with whom we are competing fiercely just to maintain our market share. No expansion of the Kenyan horticultural export market will be sustainable based on out-dated conventional pest control programmes, which rely on intensive pesticide use. The future is IPM – there is no turning back. In order to compete in the export market we must have an enabling environment for IPM in Kenya.

Role of Regulatory Authorities

The regulatory authorities involved in registration have a pivotal role in this, in making IPM products available to growers with least bureaucratic delay. Regulatory authorities in other countries recognize that the pesticide regulations are not relevant to biological control agents. As a result, the Pest Control Acts have been amended to facilitate faster uptake of IPM products such as indigenous natural enemies (predators, parasitoids and entomopathogenic nematodes) and physical controls (starches, oils and detergents, etc) as well as products that are generally regarded as safe (GRAS) (vinegar, sodium bicarbonate, plant oils, etc). Their Pest Control Acts have been

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amended to specifically exempt all of these types of products from having to comply with the Pest Legislation, including that of labelling. Dudutech has provided copies of these Acts and the exemptions contained herein to the Kenyan authorities. Pesticide Chemicals Association of Kenya (PCPB) is currently amending the Pest Control Act and Dudutech has not been advised if it was decided to amend the Kenyan Act in line with international norms. This meeting will be an opportunity for PCBP to bring participants up to date on progress.

Unlike all other countries, Kenya has insisted that the Dudutech indigenous natural enemies must be registered. The data package requirements have not been discussed by the Registrations Committee hence there was some confusion and delay in finalizing the documentation required. The process has taken from October 2002 and PCPB has still not given Dudutech permission to sell Kenyan indigenous natural enemies to the Kenyan horticultural market. Zambia, Zimbabwe and South Africa are all developing a natural enemy mass-production capability. If we do not provide an enabling environment, the ability of the Kenyan horticultural industry to compete internationally will be seriously jeopardized, without any additional safeguard to the environment being provided by the delays.

Need for Registration

Biopesticides are a different type of biological control agent from natural enemies, which should not be exempted in the same way from registration, unless the agents work purely as biofertilizers, by promoting growth of healthy plants able to withstand pest and disease attacks. The need for registration and the extent of the data package for individual biopesticides should be made on risk assessment. Internationally there is much experience on risk assessment and Dudutech welcomes this initiative to discuss these issues with the Kenyan industry and authorities. Legislation should be designed to protect the environment as well as consumers and operators. If there is no measurable risk attached to the use of specific biopesticides, Dudutech would urge the Kenyan authorities to make use of these guidelines in providing a transparent enabling environment for the registration of biopesticides as well as natural enemies in Kenya.

Discussion

Question
What percentage of synthetic pesticides has Homegrown stopped using?

Answer
Organophosphates, carbamates and organochlorine compounds have been reduced by 2,000 kg to 0 kg usage.

Question
How do you intend to address registration issues?

Answer
We have provided all requirements to PCPB, but we are waiting for feedback. We do not intend to file patent application.

Question
What benefit sharing arrangements exist with Government? How do you intend to tackle benefit sharing as contained in [illegible] and TRIPS?

Answer
These issues are always taken into considerations when planning our activities.

Neem-Based Pesticides and Registration Requirements

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Introduction

Although the benefits derived from the neem tree have been known for over 5,000 years in India, it is only in the past 30 years that these have been accepted in the western world. It was due to the efforts of Prof Heinz Schmuttrerer, a lecturer in the University of Nairobi in the 1960s and later professor of entomology in the University of Giessen, Germany, that information on neem was broadly distributed. This was through PhD and masters theses on various aspects of neem written by his students. In Kenya, Saroc Ltd., later called Saroneem Biopesticides Ltd., was the implementer, in 1996 of the production of neem extracts as pest controllers. In fact, although the tree had been on the continent for several hundred years, this was the first time that the industrial and commercial potential of the plant was exploited in Africa.

Mode of Action

Neem biopest controllers work in four basic ways:

1. Neem kills certain insects at early instar.
2. It is an anti feedant. This means that not only are insects repelled by the taste or the smell of the plant that has been sprayed, but neem also brings on a type of bulimia whereby the insect loses its appetite if it perches on the leaf and, in fact would starve to death if it remained long enough.
3. Neem has a genetic effect, in that the offspring of affected insects do not grow true to type. They may have no wings or no mouth and thus are unlikely to survive.
4. Finally, and most important, it has little effect on the predators and parasitoids that prey on insects that destroy crops.

Registration

The neem molecule contains 99 terpenoids or limonoids. Of these, the most important are azadiractin, nimbin and saladin. Most registration organizations require the presence of azadiractin to determine the efficacy of the insect controller. However, this is not correct as neem oil has virtually no azadiractin but contains considerable amounts of the other two limonoids as shown in Table 1.

Table 1: Limonoid content of neem seed cake and neem oil

	Limonoid content (%)	
Limonoid	**Cake**	**Oil**
Azadiractin	0.8	0.003
Nimbin	0.8	1.8
Salanin	0.4	0.7

It is therefore recommended that any high performance liquid chromatography (HPLC) analysis registers not only the azadiractin but also the contents of nimbin and salanin in order to determine the efficacy of the pest controller.

As biopesticides are mostly produced by young enthusiastic companies with limited financial resources, it is recommended that toxicological data from other sources be permitted to be utilized as carrying out specific studies is too onerous to permit many companies to register their products. These studies have often been published in scientific papers and are available for all to study.

Discussion

Comment
The chemistry of neem is complicated, making simple chemical standardization of neem difficult.

Response
This is so.

Comment
Because of complex action and neem 'sample knockdown', efficacy tests may be appropriate tests to suit the mode of action and the product.

Response
Agreed.

Contribution of Research in Africa

Biological Control Opportunities

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Abstract

Natural biological control agents have a profound effect on the regulation of pest populations. However their impact on the suppression of pests can be severely compromised by prevailing agricultural practices, the environment and the use of chemical pesticides. Biocontrol agents include macro-organisms (macrobials) and relatively smaller micro-organisms (microbials). The major macrobials are parasitoids, predators, invertebrates, reptiles, birds and mammals while microbials are mainly bacteria, viruses, fungi, nematodes, protozoans and rickettsia. The potential for utilizing biocontrol agents in pest management with an emphasis on agriculture is discussed.

Introduction

Pests (arthropods, diseases and weeds) coexist with their natural enemies, which determine their numbers and the degree of damage they would cause to crops, livestock and human health. However, natural regulation is severely disrupted by human activities on the ecosystem or natural catastrophes, such as bad weather, providing the pests an opportunity to increase beyond the economic threshold. Certainly the economic threshold depends on the value of the crop where even low numbers of pests may be significant in terms of crop loss. Biological control agents may therefore not forestall or prevent economic losses but are an integral part of pest management. Their effectiveness will depend on their relative ability to maintain pest populations at non-damaging levels. Compatibility with other pest management strategies is a crucial element in determining the contribution of biocontrol agents in any crop production system.

The main biological control agents can be classified as macro-organisms (macrobials) which include parasitoids, predators, invertebrates, vertebrates (birds and mammals). In addition micro-organisms (microbials) regulate pest number by causing direct mortality or by their toxins. These include viruses, bacteria, nematodes, protozoa and rickettsia. Some of the microbials do not cause death but out-compete the pathogenic organism as antagonists and consequently ameliorate the effect of the disease on the crop, e.g. *Trichoderma* spp. and *Fusarium oxysporum* (biological fungicides).

The downside of biological control agents is their specificity as opposed to being broad spectrum pesticides, underscoring the need to use more agents or other intervention strategies to manage the variety of pests which occur on any one crop.

Macrobial Biocontrol Agents

Some macro-organisms are non-specific predators of arthropod pests that exert considerable suppression of these pests, especially when they appear in large numbers. These include spiders, praying mantis, birds, reptiles and small mammals. Some of

these generalists are also able to disseminate arthropod diseases after feeding on infected pests as the infective organisms pass through their gut without being inactivated. Birds are known to do this very effectively as they are highly mobile.

More specific macrobials include predators and parasitoids that can be manipulated to confer optimum pest suppression by *in situ* conservation, introduction or augmentation. *In situ* conservation of endemic natural enemies can be enhanced by habitat management such as provision of refugia, increasing food and shelter or multiple cropping including flowering plants. However use of chemical pesticides often decimates natural enemies. It is conservatively estimated that 52 per cent of total pesticide imports (6383.6 tonnes in 2000) goes to horticultural crops pest management.

Where exotic pests are involved it is often more prudent to introduce appropriate natural enemies from the pest area of origin. This approach is referred to as classical biological control. Once the natural enemies are introduced they may establish and continue to reproduce and suppress the target pests for a long time.

Augmentation of natural enemies may entail introduction of small quantities, inoculative release, or frequent timed introductions, inundative release, or massive releases during a critical stage of the cropping season. The latter approach is appropriate for introducing pest pathogens that readily suppress the pests in a similar manner to that of chemical pesticides. Greathead (1971) discusses some of the successful biocontrol agents within the Ethiopian region.

The success of any natural enemies to suppress pests depends on the ability to search for the pest, reproduction capacity, survival and host specificity.

Some of the predators that have had considerable suppression of crop pests are:

- Beetles — Carabids
  Coccinellids (ladybirds)
- Flies — Syrphids (hover flies)
- Bugs — Anthocorids (*Orius*)
  Lygaeids
  Mirids
  Reduviids
- Wasps — Sphegids
  Vespids
- Predatory mites — Phytoseiids
- Lacewings — Chrysopids
- Praying mantis — Mantids
- Ants — Formicids

Some important parasitoids of crop pests include:

- Wasps — Inchneumonids (*Diadegma, Trichogramma*)
  Braconids (*Cotesia*, *Aphidius*)
  Eulophids (*Tetrastichus*, *Diglyphus*)
  Pteromalids (*Antestiopsis*)
  Scelionids (*Telenomus*)
  Encyrtid (*Copidosoma*, *Anagyrus*)
  Eupelmids (*Eupelmus*)

•	Flies	Chalcidids (*Brachymeria*) Aphelinids (*Encarsia*) Techinids (*Linnaemyia*) Agromyzids.

Microbial Biocontrol Agents

Unlike their macrobial counterparts, microbials behave in a similar way to chemical pesticides as they are quantifiable in terms of infective units or concentration of toxins and may thus be referred to as biopesticides. The most important arthropod pest pathogens include:

- **Viruses –** ingested and cause mortality in 3–10 days, propagated *in vitro* and safe to higher mammals
- **Bacteria –** ingested, cause mortality in 30 minutes to 1 day, many propagated *in vitro*, most safe to mammals and beneficial arthropods
- **Fungi –** enter host through cuticle, cause mortality in 4–7 days, propagated *in vitro* not totally safe to mammals and beneficial arthropods
- **Protozoa –** acquired orally, chronic infections, propagation *in vivo*, safe to mammals and useful arthropods
- **Rickettsia –** transmitted via eggs, propagation *in vivo*, many very virulent, safety to mammals doubtful as well as to some beneficials, cause variable mortality but may reduce fecundity
- **Nematodes –** some propagated *in vitro*, sometimes cause epizootics, act slowly and best for pests living in cryptic habitats, safe for mammals but may harm beneficial arthropods.

The most exploited organisms, in order of importance, are entomopathogenic viruses, fungi, bacteria and nematodes.

Entomopathogenic Viruses
Major families of insect pathogenic viruses include:

- *Baculoviridae* (nucleopolyhedrovirus, NPV, and *granulosis virus*, GV)
- *Reoviridae* (*cytoplasmic polyhedral virus*, CPV)
- *Entomopoxviridae* (EPV)
- *Iridoviridae* (*iridio virus*, IV)
- *Ascoviridae*
- *Birnaviridae*
- *Caliciviridae*
- *Nodaviridae*
- *Parvoviridae* (*denso virus*, DNV)
- *Picornaviridae*
- *Polydnaviridae*
- *Rhabdoviridae*
- *Tetraviridae*
- *Oryctes virus* (now *Baculoviridae*).

Baculoviruses that include *granulosis virus* (GV) and nucleopolyhedrovirus (NPV) are most studied and offer the best opportunity for arthropod pest control. Their virus particles develop within a crystalline-protein structure, occlusion body (OB), which protects the virion outside the host. Once ingested the alkaline insect gut dissolves the

protein envelope. This releases the virions, which rapidly multiply in the haemocoel killing the host in 1–3 days, and their bodies rupture releasing millions of OBs.

One of the salient features of baculoviruses is their multiple modes of dispersal by adult pests (auto dissemination), by restless sick larvae climbing to tops of plants to die, by aerial drift of larvae by silk threads (ballooning), and by birds, predators or casual humans. The viruses also survive through predators and birds, which disseminate the inoculum through droppings. Soil and crop litter are good reservoirs of the viruses while soil inhabitants feeding on organic matter can recycle the viruses. The viruses are however inactivated by ultra violet light and heat. They may also be inactivated by physical-chemical properties of leaves on certain plants. Wind and rainwater could cause attrition of the OBs from crops. In order to enhance these biopesticides formulation should include adjuvants, wetters, spreaders, stickers and UV masking agents.

There are several biopesticides based on baculoviruses e.g.

- *Anagrapha falcifera* NPV
- *Spodoptera exempta* NPV
- *Helicoverpa armigera* NPV.

Recently KARI/CAB International identified and tested the *Diamondback moth granulosis virus* (PxGV). From this work it was found that baculoviruses vary serologically and in efficacy and should be precisely determined to strain before being developed into pesticides. It is also equally important to stabilize the final product in order to achieve the desired level of pest suppression. The conditions and time of application may also be crucial to ensure that the biopesticide remains active on the target surface for a considerable period.

Entomopathogenic Bacteria
Bacteria, especially the spore forming *Bacillus* species, infect arthropod pests after ingestion. During sporulation, *Bacillus thuringiensis* (*Bt*) cells produce a large protein crystal in addition to a thick-walled endospore. The crystal is an inert toxin (endotoxin) which, after ingestion by a suitable host, is dissolved by the alkaline gut, thereby releasing the toxin which infects the gut and the haemocoel inducing lethal septicaemia. Hosts die within a few days from a milky disease and, as they decay, bacterial spores are released into the soil where they persist as reservoirs for the next host. Some commercial products based on entomopathogenic bacteria are:

- *Bacillus thuringiensis* subsp. *kurstaki* (Thuricide)
- *Bt* subsp. *aizawai* (Xentari).

An endotoxin from *Bt* has also been produced as a commercial insecticide (*Bacillus thuringiensis* delta endotoxin). *Pasteuria penetrans* also suppresses root knot nematodes.

Entomopathogenic Fungi
Several entomopathogenic fungi are found in the subdivisions Mastigomycotina, Zygomycotina, Ascomycotina and Deuteromycotina. Arthoropod infesting fungi almost invariably penetrate the host cuticle directly using complex enzymes. The host usually dies from mycosis caused by extensive mycelial colonization of the haemocoel but in higher fungi mortality is caused by a toxin released by the yeast phase.

Some of the fungal products which are under development or are commercialized include:

- *Beauveria bassiana*
- *Zoophthora radicans*
- *Metarhizium anisopliae*
- *Paecilomyces fumosoroseus*
- *Verticillium lecani (Pochonia glamidosporium)*
- *V. chlamydosporium*
- *Trichoderma* sp.
- *Fusarium oxysporum*

Entomopathogenic Protozoa and Nematodes
When ingested by insects some protozoa multiply, destroying the normal functions of the host. The infection is chronic and would kill only when the organisms are too numerous. The most important entomopathogenic phylum is Microspora, which significantly reduces host development and fecundity. *Nosema* and *Vairimorpha* are important genera, which can be explored for use as biocontrol agents.

Entomopathogenic nematodes, mainly in the genera Steinernematidae and Heterorhabditidae, are important parasites of arthropod pests. Their juveniles enter the host via the mouth, anus or cuticle and multiply in the haemocoel, killing the host. Some of the locally isolated nematodes, more than two hundred isolates, have been found to be pathogenic to local pests. The association of nematodes with bacteria in the genus *Xenorhabdus* and *Photorhabdus* increases their pathogenicity.

Some of the local isolates that have been characterized include:

- *Steinernema karii* sp.n
- *Heterorhabditis bacteriophora*
- *H. indica.*

Conclusion

Biocontrol agents vary from large macrobials to smaller microbials. Toxins may enhance their direct effect on hosts. Conventional chemical pesticides depress the activity of biocontrol agents. Use of selective and benign pesticides such as insect growth regulators, fermentation products and hormonal mimics can be compatible with biocontrol agents in an integrated pest management strategy. Semiochemicals and allelochemicals, especially attractants, pheromones and kairomones which influence the behaviour of the arthropod pest, can enhance the effectiveness of biocontrol agents and biopesticides.

Reference

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Discussion

Comment
What industry desperately needs is alternatives to chemical pesticides. We must reduce the use of pesticides. We need products which will replace pesticides. It is an urgent issue to inform and develop legislation to enable the full potential of IPM to be realized. KARI has an exceptional track record of research in biological control and a vast number of stored isolates. Let's cooperate in the commercialization of these and allow Dudutech access to these to compare their efficacy with that of the Dudutech isolates. In this way KARI may be able to realize the commercial value of these isolates. At present Dudutech is not even allowed to sell indigenous predators and parasites, of local origin but which have been used successfully for decades throughout the world.

Let's do less talking about IPM and implement programmes that will enable predators, parasites, entomopathogenic nematodes and finally biopesticides to be made available to growers.

Question
Do most products have temporary legislation?

Answer
No, but the allocation of temporary legislation depends on how important the missing data are for consideration of use. If very important, then registration will not be provided.

Baculoviruses and Bacteria as Potential Tools in Crop Protection

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Abstract

Some insect pathogens have potential for use as biopesticides. These include bacteria, fungi, viruses, nematodes and protozoa, which could be produced *in vivo* or *in vitro* for small-scale or large-scale application in management of target pests. Although they do not give a lasting solution, biopesticides are used in the same way as insecticides, thus making them highly adaptable to many established pest management programmes. Advances in biotechnology would allow production costs to decrease and efficiency to increase, thus making them even more appealing. In Kenya, there are several insect pests susceptible to these biopesticides. Several *Bacillus thuringiensis (Bt)* commercial formulations have been registered and are available in the market for use in controlling such pests, but their use is still limited due to the cost, lack of knowledge on their existence by the potential users, and non-existence of regulation and registration guidelines. Presently less than one per cent of biopesticides is sold in the world market. The issues of registration and perceived risks affect the progress in development of biopesticides and the sooner this is resolved, the better for the industry. The development and use of bacterial and viral biopesticides in crop protection is discussed.

Introduction

In recent years, microbial insecticides or biopesticides have emerged as significant pest management components and rapid development has taken place in terms of research and commercialization. This is partly because consumer markets are becoming increasingly aware of the environmental concerns and are making demands on the industry to move towards a more ecologically rational approach to pest management. Several insect pathogens bacteria, fungi, viruses, nematodes, rickettisia and protozoa have potential for use as biopesticides and have been tested for their ability to control insect pests. Naturally, these micro-organisms often cause epidemics in insect populations that help in regulating them. Because of ease of handling, most of them have been used or studied for use and formulated into baits, dusts, granules, and sprays and delivered in ways similar to those of conventional chemical insecticides to control target pests. Such biological control preparations have label directions like insecticides and are registered with the appropriate authority. To date, the pathogens most widely used as microbial insecticides are bacteria, fungi and viruses; the rest are not used extensively as they have the disadvantage of being slow to kill insects.

According to Butt *et al.* (2001), recent rapid advances in biopesticides technology have concentrated on developed country markets and a high-tech approaches. This technology can however be effectively adapted to meet African needs and conditions through some innovative stages: characterization of effective local pathogens for African pests; development of appropriate pathogen application technology;

development of novel biopesticides formulations based on locally available agricultural by-products; and development of novel and appropriate technology for small-scale and commercial production of biopesticides. Research studies in recent years indicate existence of several local *Bacillus thuringiensis (Bt)* strains and some baculoviruses. This, together with the availability of production materials locally, and readily available production technology, offers an opportunity for launching a successful process of producing biopesticides as in Latin America and Asia. With a cost-effective production system, the potential for biopesticides use in Kenya is enormous. Encouragement of small-scale *in vivo* production by organizations such as NGOs, farmers groups and research institutes, using locally isolated strains, may help to pave way for future commercial production.

Bacterial and viral based biopesticides have been produced commercially in some developed countries for use on agricultural and forestry pests, especially those belonging to the order Lepidoptera. Their use is also rapidly expanding to other developing countries. Among bacteria, *Bt* has been the most exploited commercially, while members of baculoviruses have been the most used among the viruses, because of their virulence, specificity to insect pests and safety to man and the environment. The future of biopesticides appears to be assured considering the increasing problems of resistance and environmental contamination with conventional insecticides, which is creating a compelling need for safer alternatives. However, it would be important to initiate a kind of government innovative foundation that would take up the role of formulating, producing and selling these products locally, without necessarily looking for huge profit margins, in order to encourage and sustain their use.

Biopesticides have the potential for the management of key African insect pests of food and cash crops; they are environmentally safe, host specific and non-persistent and can be substitutes for the expensive imported pesticides. They can also improve the quality of export and local market produce by eliminating the risks of pesticides.

Bacterial and Viral Biopesticides

Bacillus thuringiensis (Bt)
Known bacterial biopesticides are *Bacillus thuringiensis*, *B. popilliae*, and *B. sphaericus* (Table 1). *B. thuringiensis* Berliner is a widely distributed, rod-shaped, spore-forming, aerobic, gram-positive bacterium. It is the most widely used pathogen for microbial control of insect pests and has been tested against a wide spectrum of insects including Lepidoptera and Diptera in the laboratory and field (Krieg and Langenbruch, 1981).

Table 1: Main bacterial control agents of insects

Species	Active component	Principal insect
Bacillus thuringiensis var. kurstaki	Spores and crystal endotoxin	Lepidoptera
Bt israelensis	Spores and crystal endotoxin	Diptera (mosquitoes blackflies)
B. sphaericus	Spores, some toxin	Diptera (mosquitoes)
B. popilliae	Spores	Coleoptera (Scarabaeidae)

It is a complex species divisible into more than 20 varieties (or H serotypes) by serological and biochemical tests. *Bt* is reported to produce a proteinaceous parasporal

body delta-endotoxin or crystal toxin during sporulation (Hanny, 1953), which is extremely toxic to target insects. However, it causes little or no harm to humans, most beneficial insects and other non-target organisms. It is the principal insecticidal component of the commercial preparations. The *Bt* toxin exists in three size molecules designated 125–138, 65–75, and 25–28 kilodaltons and are encoded by CryI and CryIV; Cry, CryIII and CryIV and the Cyt genes, respectively (Haider and Ellar, 1989). They are further proteolytically converted into smaller toxic polypeptides (Hofte and White, 1989).

Nucleopolyhedroviruses (NPVs)

More than 600 baculoviruses have been isolated from arthropods, mainly insects, and some have been successfully used for the control of many lepidopteran, hymenopteran and coleopteran pests. They have a circular double-stranded DNA and are members of the *Baculoviridae* family. This family is divided into two subfamilies, *Eubaculovirinae* and *Nudibaculovirinae*. The *Eubaculovirinae* consist of the occluded baculoviruses, which include the nucleopolyhedrovirus (NPV) and *granulovirus* (GV) genera (Table 2).

Table 2: Members of the Family *Baculoviridae*

Genus	Subgenus	Subfamily	Type/Species	OB
NPV	MNPV	*Eubaculovirinae*	AcMNPV	+
	SNPV	*Eubaculovirinae*	BmSNPV	+
GV	–	*Eubaculovirinae*	PiGV	+
NOB	–	*Nudibaculovirinae*	HzNOB	-

OB = occlusion body; NPV = nucleopolyhedrovirus (or nuclear polyhedrovirus); SNPV = single nuclear polyhedrovirus; MNPV = multiple nuclear polyhedrovirus
AcMNPV = *Autographa californica nuclear polyhedrovirus*
BmSNPV = *Bombyx mori nuclear polyhedrovirus*
PiGV = *Plodia interpunctella granulovirus*
HzNOB = *Helicoverpa zea nonoccluded baculovirus*.
From: McIntosh and Grasela, 1994

The NPV replicate within the nuclei of invertebrate cells and occlude virions (virus particles) within occlusion bodies (OBs), a proteinaceous matrix, also known as polyhedra. The NPV genus is further subdivided into two subgenera: single nuclear polyhedrovirus (SNPV) in which virions or enveloped nucleocapsids are packaged into OB singly, and multiple nuclear polyhedrovirus (MNPV) in which two or more viruses are embedded into the OB. The GV replicate partially within the nucleus and cytoplasm and are individually occluded and singly enveloped. The Nudibaculovirinae consist of the non-occluded baculoviruses, which are singly enveloped and do not produce OBs. NPVs are the mostly studied because of their ease to grow in cell culture.

Host Range of *Bt* and NPV

Bt

Since the discovery of Bt, several infectivity tests have been conducted in the laboratory to find out the susceptibility of different pests. Most *Bt* serotypes have been found to be pathogenic of larvae to Lepidoptera. Krieg *et al.* (1982) outlined arthropod susceptible to *Bt*, and also the variety of *Bt* involved in the laboratory or in the field. Some *Bt* strains have also been found to be pathogenic to some insects belonging to

Diptera and Coleoptera. Some of the local crop pests that have been found to be susceptible to *Bt* include: *Chilo partellus, Busseola fusca, Maruca testulalis,* and *Plutella xylostella* (Kariuki, 1987; Oketch, 2001; Thumbi, 2001). The host range and toxin composition for some strains of *Bt* is as indicated in Table 3.

Table 3: Host range and toxin composition for some strains of *Bt*

Strain or subspecies	Insect host	Delta endotoxin
kurstaki HD-1 (*Btk*)	Lepidoptera	CryIA(a), CryIA(b), CryIA(c), CryIIA
	Diptera	CryIIB
kurstaki HD-73	Lepidoptera	CryIA(c)
thuringiensis HD-2 (*Btt*)	Lepidoptera	CryIA, CryIB
aizawai (*Bta*)	Lepidoptera	CryIA(a), CryIA(b), CryIC, CryID
entomocidus (*Bte*)	Lepidoptera	CryIA(a), CryIB, CryIC
tenebrionis (*Btn*)	Coleoptera	CryIIIA
israelensis (*Bti*)	Diptera	CryVA, CryIVB, CryIVC, CryIVD, CytA

From: Tabashnik, 1994

NPV

Baculoviruses have been isolated from a wide variety of insect pests from several orders, including Lepidoptera (with most isolates) and Coleoptera (Goodman and McIntosh, 1994; Adams, 1991). Individual baculoviruses have a limited host range, usually only infecting the target insects and a few closely related insect species in particular ecosystems. They therefore have minimal potential for damaging the environment (Goodman and McIntosh, 1994). The MNPVs in general have a wider host range than SNPVs and other baculoviruses in the family Baculoviridae, as evidenced in both *in vivo* and *in vitro* systems (McIntosh and Grasela, 1994; Harper, 1976). Among MNPVs, AcMNPV and AfMNPV have the widest *in vitro* and *in vivo* host range respectively (McIntosh and McIntosh, 1994). A recently isolated MNPV of diamondback moth, *Plutella xylostella*, PxMNPV, has also been shown to be infective to several lepidopteran hosts and their derivatives cell line (Kariuki and McIntosh, 1999). Some of the *in vivo* and in *vitro* host range of baculoviruses is as indicated in Table 4.

Mode of Action of *Bt* and NPV

Bt

Upon ingestion of *Bt*, the right combination of pH, salts and enzyme in the digestive system breakdown and activate the highly insoluble crystals. Following activation, the *Bt* toxins bind to high affinity receptors (glycoproteins) on the midgut epithelium, which result in generation of pores on the cell membrane, thus disturbing cellular osmotic balance and causing the cells to swell and lyse by the process of 'colloid-osmotic lysis' (Adang, 1991). This results in leakage of the alkaline gut contents into the haemocoel, which might be severe enough to kill the larvae and may cause changes within the larvae, which allow growth of *Bt* or other organisms, resulting in septicaemia. Damage to the larval digestive tract also causes it to stop feeding in 15 minutes to 1 hour after *Bt* ingestion. Combinations of the leakage, lack of feeding and septicaemia usually kills the insect within one to several days depending on the dose,

Table 4: *In vivo* and *in vitro* hosts of AcMNPV, AfMNPV and PxMNPV

Insect host	Larval host	Cell line
Autographa calfornica	+	+
Plutella xylostella	+	+
Heliothis zea	+	-
H. subflexa	+	+
H. virescens	+	+
Trichoplusia ni	+	+
Spodoptera frugiperda	+	+
S. exigua	+	+

AcMNPV = *Autographa californica multiple nuclear polyhedrovirus*
AfMNPV = *Anagrapha farcifera multiple nuclear polyhedrovirus*
PxMNPV = *Plutella xylostella multiple nuclear polyhedrovirus*
From: McIntosh and Grasela, 1994; Kariuki *et al.*, 2000

species and environmental conditions. Lack of feeding results in lower crop damage, even if the caterpillar may not die quickly.

NPV
Nucleopolyhedroviruses are highly virulent and infection occurs after susceptible insect larvae eat food contaminated with the virus. After ingestion, the OBs are dissolved in the insect gut lumen by the alkaline environment in Lepidoptera and Hymenoptera and digestive proteases, releasing the enveloped virions. The virus enters the midgut cells, especially the columnar epithelial cells, by fusion with the membranes. The nucleocapsids are released, enter the cell and migrate to the nucleus through the nuclear pores. Replication of the virus follows infection of major tissues such as body fat, trachea, hypodermis and haemocytes, and the massive destruction of the body tissues that accompanies production of OB kills the insect in 3–10 days. Before death, infected larvae may gather in a typical way at the tip of the plants, cease feeding, the integument changes in colour and lustre, and the insect becomes flaccid and fragile. Upon death the insect rapidly darkens and the body ruptures to release millions of OBs.

Production of Biopesticides

Bt is an ideal organism for large-scale commercial production because it grows easily in submerged cultures using conventional fermentation equipment. Stock cultures are best preserved as freeze-dried samples. In addition, spores also retain their viability on agar slants for a long period. For mass production of *Bt* the following general steps are involved:

1. Culture storage and maintenance
2. Propagation
3. Fermentation
4. Down-stream processing
5. Formulation and storage.

The first commercial product containing *Bt*, Sporein, was produced in France before 1938. Present worldwide production is in the order of several million tonnes with

leading manufacturers in the US and Europe. Some of the products available in the market include: Thuricide, Dipel, Certan, Xentari, Greenguard.

Production of NPVs can be achieved through *in vitro* and *in vivo* methods. These methods are quite often used in the laboratory for production of a small quantity of the virus. *In vitro* production involves the inoculation of susceptible insect cells with NPV after harvesting of OBs from cells by sonication and centrifugation to concentrate them. The *in vivo* method involves the use of whole insect larvae to produce the virus. The larvae are fed on artificial/natural diet inoculated with the virus and the OBs are harvested from dead infected larvae by homogenizing the carcasses and sieving through cheesecloth, followed by a series of differential centrifugation of the OB suspension (Kariuki, 1996). Commercial production of NPVs depends upon mass rearing and infection of host insect larvae as described in the *in vivo* method above. Occlusion bodies collected from diseased last-instar larvae are concentrated, purified and formulated with various adjuvants into wettable powder for subsequent field use (McIntosh and Ignaffo, 1981). Commercial *in vitro* production has not been possible as it depends on mass culturing on insect cells in a high-cost serum containing medium. Unlike *Bt,* production of NPV *in vitro* is rather expensive and this is one of the factors that has hampered their development. However, recent development of serum-free media has resulted in greatly reduced medium costs (Shuler *et al*., 1990; Agathos, 1994). Some of the NPV products that have been produced commercially include: Gemstar (*Helicoverpa* zea NPV), Gypcheck (*Lymantra dispar* NPV), SPOD-X LC (*Spodoptera* spp. NPV), Biotnel (*Trichoplusia ni* NPV), Neochek (*Neodiprion sertifer* NPV) etc.

Role of *Bt* and NPV in Pest Control

Because of their ability to kill insects considered harmful, *Bt* and NPV have undergone fast development for the purpose of use in the field. Today they are being used in integrated pest management (IPM) programmes for short-term control of pests. Both can successfully and safely be used in augmentative biological control where they are actively produced and released repeatedly (inundative) to control pest populations. *Bt* and NPV are used for short-term control because they are short-lived in the environment. They are therefore applied repeatedly like conventional chemical insecticides to control a wide range of lepidopterous defoliators in agricultural crops and forests. Although the use of these biopesticides is not intensive in Africa, studies in Kenya have demonstrated their potential in control of many agriculturally important pests such as *Helicoverpa armigera, Plutella xylostella, Phthorimaea operculella, Chiolo partellus, Busseola fusca*, and *Maruca testulalis* (Kariuki, 1987; Baya *et al*., 2001; Brownbridge, 1990; Kibata *et al*., 1999).

The major disadvantage of *Bt* and NPV is the rapid disappearance of their activity in the field and inability to spread in insect populations. This is due to inactivation by solar radiation (UV). Also the narrow host range is a disadvantage in comparison to chemical insecticide. To circumvent these problems, advanced technology involving genetic engineering is applied as discussed below.

Improvement of Biopesticides

This is usually done in order to improve their host range, virulence and delivery. This can be achieved by using them synergistically in combination with other microbial or chemical insecticides. Genetic engineering is also done, especially with NPVs, with the main goal of enhancing their marketability. They are therefore modified to enhance

virulence – since NPVs would require several days to kill insects, during which time they are still actively feeding and causing crop damage. Development of faster-acting viruses enhances their overall effectiveness as insect control agents in agricultural settings (Goodman and McIntosh, 1994).

A variety of genes have been inserted in the NPV genome that have the potential for disrupting physiological process such as digestion or moulting. Such genes are: *Bt* delta endotoxin gene, insect hormone genes, insect enzyme genes, insect venom genes and invertebrate neurotoxin. NPVs are also modified in order to expand their host ranges. This is because many of them infect only insects within one family or genus, which limits their marketability. The usefulness of *Bt* has been increased partly due to technical innovations that allow expression of *Bt* toxin genes in transgenic crop plants (Tabashnik, 1994), thus enhancing its infectivity and delivery.

Regulation and Registration

According to Goettel *et al.* (2001), many regulation and registration requirements serve the purpose of ensuring the safety of the agent and efficacy. However, these have not been encouraging to the development and registration of biopesticides because the biological control agents have been put together with other acts dealing with plants, noxious weeds etc. Many are also regulated by legislation initially designed for chemical pesticides, and a separate review system for biopesticides from that for conventional pesticides will be needed. Many countries in Europe and America including organizations such the Food and Agricultural Organization (FAO) have been drawing up new regulations for biopesticides. Different countries also have different data requirements for registration and harmonization is needed in order to reduce the cost of registration of the product.

General data requirements for registration of microbial pathogens (Adapted from OECD, 1996) are as follows:

- Identity
- Physical, chemical and biological properties
- Function, mode of action and handling
- Manufacturing, quality control and analytical methods
- Residues
- Efficacy
- Toxicology
- Ecotoxicology
- Effect on environment.

Although biopesticides do not possess properties that would make them potentially hazardous, assessment of their potential risk is important. This is also important because the intention of developing them is to commercialize them, and so registration and regulation are needed to protect all the stakeholders involved.

Conclusions

The use of biopesticides in Kenya is at the moment on the low side, but potential exists considering the huge horticultural industry (major user of chemical pesticides) which is second only to tea in terms of export. A greater percentage of vegetable export is

destined for the European Union market which has recently introduced the pesticide maximum residue levels (MRLs) requirement that all horticultural produce to EU market has to meet. With the anticipation of an introduction of zero tolerance sooner or later, Kenya has to start embracing environmentally safe methods of pest control now, if it is to continue enjoying and sustaining monopoly in this market. A delay in implementing such methods in pest management will result in the loss of market to other competing countries that are anxiously taking on board modern and safe methods of pest management.

The rapid development of biopesticides in some countries such as India and those in SE Asia was partly driven by the urgent need of safer alternatives as a result of massive pesticides resistance that nearly brought horticultural production to a halt. We will not need to wait for that to happen and it is therefore advisable to start now before the situation gets out of hand as cases of resistance to pesticides have been on the increase, especially with diamondback moth, african bollworm, red spider mite and others.

In order to hasten the utilization of biopesticides, the prevailing policy environment needs to be enabling and conducive. For instance it would be important for the Government to implement an Integrated Pest Management (IPM) Policy especially in the horticultural industry so that the producers and other stakeholders feel obliged to adopt environmentally friendly methods for pest management in production. In time, this will change the industry from total dependence on chemical pesticides as a panacea to pest problems, to one driven by the need for production of quality food for both local and export markets. The presence of an efficient and thorough registration and regulation mechanism will also be important in development of biopesticides. The registration should be encouraging to local commercial producers who are willing to venture into production of biopesticides using locally isolated strains or plant materials.

Production of biopesticides is expensive and require government support/intervention to kick off before interested private commercial entrepreneurs could join in. Through the IPM Policy, the Government could levy manufacturers and sellers of chemical pesticides a small feed that could fund the development of pesticides in the country. For instance, through bilateral assistance, the Government could create an innovative foundation under any of the institutes (such as university, research institute etc.) to develop, build and run a biopesticides production plant in the country using locally identified pathogens. Products of this plant could be used for field trials in IPM programmes for a wide range of pests, and to train its technical staff and scientists in biopesticides use. This will ensure that biopesticides are integrated into unified crop protection programmes at affordable cost to growers.

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Development, Registration and Commercialization of Biopesticides: The Case Study of 'Green Muscle®'

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Abstract

Locusts and grasshoppers cause enormous damage to crops in many countries, especially in Africa. Attempts to control them have relied heavily on the use of synthetic insecticides. The LUBILOSA (Biological Control of Locusts and Grasshoppers) project was formulated to develop a biopesticide against these pests. Surveys in West and North Africa identified the fungus *Metarhizium anisopliae* var *acridum* isolate IMI 330189 as the most promising biological control agent. The complex processes of developing the biopesticide product e.g. formulation, storage, production were successfully implemented and the route to develop a commercial product was agreed upon. Biological Control Products (BCP), based in South Africa was identified as the most suitable commercial company to manufacture, market and sell the product (eventually known as 'Green Muscle®'). Problems of disclosure, sharing and exchange of information were solved mutually.

Introduction

Appropriate management of intellectual property (IP) generated by public sector research and development (R&D) organizations is an increasingly important issue as institutes struggle to balance their public service role with the opportunities for benefit from their IP through the commercial sector. The need for the exploitation of IP has emphasized the importance of collaboration between the public sector R&D institution, client, development partner and commercial sector. The 'Biological Control of Locusts and Grasshoppers' (LUBILOSA), a collaborative programme between CAB International (CABI), International Institute of Tropical Agriculture (IITA), DFPV (Programme Majeure Formation, Protection des Végétaux), Deutsche Gesellchaft für Technische Zusammenarbeit (GTZ) and CILSS (Interstate Committee for Drought Control in the Sahel), provides a case where all partners' interests were catered for in the exploitation of an IP developed by the public sector and marketed by the commercial sector.

Scientific papers on the identity, production storage etc. of the product were freely published, whereas technical procedures required for formulation to use the product were patented by CABI and transferred to Biological Control Products (BCP) under strict Confidentiality and Licensing Agreement. Benefits arising from the development of Green Muscle® include access to the technology and the environmental, economic and social benefits that accrue from it, capacity building through training and royalties generated from the sale of Green Muscle. The monies generated from the royalties on the sale of Green Muscle in Africa are deposited into a Trust Fund, to support collaborative initiatives associated with promoting biopesticide development and use in Africa.

The Challenge

Appropriate management of IP generated by public sector R&D organizations is an increasingly important issue. The difficulties are perhaps most evident with public organizations involved in development assistance work, i.e. their mandate to make all information freely available is not consistent with commercialization of IP. The advent of 'biotechnology', with its potential benefits, has highlighted the need for public sector R&D institutions to be able to work with sponsors, clients and commercial companies but these new relationships can create conflict between the needs of the different stakeholders.

There are, however, some success stories.

The LUBILOSA Programme

- Biological control was considered to be such an alternative
- A collaborative programme entitled 'Biological Control of Locusts and Grasshoppers'(LUBILOSA) was developed in 1989
- Collaborators in the programme were: IITA, DFPV, CILSS, GTZ and CAB International
- Donors were: CIDA, DGIS, ODA (now DFID), SDC, USAID.

LUBILOSA Project Cycle

- Phase 1 (1989–91) – Established the principle of using oil formulations of fungi (*Metarhizium anisopliae*) against locusts.
- Phase 2 (1992–94) – Established that the oil formulation of the isolate IMI 330189 was effective. Mass production initiated at IITA.
- Phase 3 (1995–98) – large-scale field trials, toxicological, ecotoxicological and economic studies carried out. These studies indicated that commercialization offered the most favourable route to implementation. LUBILOSA licensed the technology to two commercial partners (BCP in South Africa and NPP in France). Registration of the product has been granted in South Africa.
- Phase 4 (1999–2001) – Commercialization of *Metarhizium anisopliae* as a biopesticide to control locusts in Africa.

Origin, distribution and access to LUBILOSA isolate IMI 330189

Product Development

The process of taking a fungal isolate and turning it into a marketable product involves a process of:

- Identification and characterization of collected isolates
- Laboratory bioassay to determine virulence
- Formulation
- Storage tests
- Mass production
- Small-scale application trials
- Large-scale trials
- Operational level trials
- Assessments of ecotoxicology and mammalian and fish toxicology
- Scale-up of production

- Preparation of registration and submission of dossier
- Identifying commercial companies to manufacture, distribute and sell the product
- Confidentiality
- Commercial, regulatory, technical and quality standards
- Identifying appropriate industrial partners
- Gathering market information
- Licensing of the technology to the private sector
- Disbursement of benefits accruing from the successful commercial exploitation of the product.

To address the above, it is essential to establish appropriate partnerships with R&D collaborators, sponsors and commercial companies. LUBILOSA provides an example of the type of problems that need to be addressed and some of the options that are available to deal with the commercialization of public sector generated intellectual property.

Green Muscle: the Product

Active Material
The active material of the mycoinsecticide Green Muscle is based on the fungus *Metarhizium anisopliae* var. *acridum*. The standard isolate is IMI 330189. This isolate has been found to be effective against a wide range of locusts and grasshoppers.

Formulations
Laboratory assays have shown that the formulation of *M. anisopliae* conidia in oil improved the efficacy and speed of kill in comparison with water-based suspensions, especially at low humidity. The programme has developed a unique oil-miscible flowable formulation.

Storage Characteristics
Long-term storage of *Metarhizium* conidia is possible provided that the moisture content is kept low (below 6%). No loss of virulence is observed after 12 months at 30°C.

Application
The LUBILOSA mycoinsecticide is compatible with all ULV spraying equipment likely to used for operational application. Rates of application of 0.5 l/ha (50 g/ha) have been successfully used.

State Registration
Green Muscle is registered in South Africa for control of Brown Locust and has been recommended by FAO Desert Locust Pesticide Referee Group for use in conservation and environmentally sensitive areas.

Public/Private Partnerships for Developing Green Muscle
The basic principle on which LUBILOSA has approached the development of Green Muscle for locust and grasshopper control has been to meet the 'public need' with a basic, workable product and system for production, which has been made readily available to the public domain. However, the LUBILOSA manufacturing process was assessed to be uneconomic. LUBILOSA is transferring its technical knowledge of

production and formulation to two companies which bring-to-bear their experience in large-scale manufacturing expertise of biopesticides.

Biological Control Products (BCP), based in South Africa, is currently licensed to manufacture, market and sell Green Muscle. It is a small-medium enterprise (SME) whose core business is to manufacture, market and sell biological control agents for use in the control of plant pathogens. Their main product is the nematicide, based on the fungus *Paecilomyces lilacinus* for the control of nematodes of tomatoes and related crops, that is registered in South Africa as 'PL Plus'. The *Paecilomyces* production plant in Pinetown utilizes a similar solid substrate system to that required for industrial scale production of *Metarhizium*.

Disclosure, Sharing and Exchange of Information

In general, public disclosure of information is considered unhelpful to commercialization of a product but the decision to, or not to, disclose information generated by a research team also has implications for individual scientists and the donors funding the research, for example:

- Public sector scientists in general
- Research workers
- Donors supporting R&D projects
- Commercial companies
- Dealing with confidentiality at the project level
- Ownership of the IP.

Commercial Company Collaboration

Interaction with a commercial company is a two-way process. The commercial company needs to be convinced that the product is commercially viable and the licensee needs to be sure that the commercial company has the wherewithall to register, manufacture, market and sell the product to the required standards and price.

Key issues for both parties to collaborate on mycoinsecticide commercialization include:

- **Product specification**: Sufficiently broad spectrum for there to be a sizeable market for the product, high virulence, good speed of kill, good storage capability, use of a conventional formulation utilizing existing application equipment.

- **Production**: Utilization of an established production process, conventional packaging and storage.

- **Markets and demand**: A number of large, regular, well-established markets, few competitive products, a specific product advantage for which there is an established demand or a well-defined niche market presently unexploited that provides an economically attractive opportunity.

- **Distribution and sales**: Product must fit within existing networks of distribution; wholesale and retail sales outlets and mechanisms need to be well established.

- **Toxicology and ecotoxicology**: Product should ideally be environmentally friendly and have low vertebrate toxicity.

- **Registration**: Product should require first tier testing only, or before entering a fast track registration process.

- **Economics**: Favourable toxicological attributes reduce development and registration costs, use of an established production process reduces development costs – production, packaging, storage and transport costs need to be low, and competitive price.

Which Companies?

There are a number of companies that already have mycoinsecticide products on the market and a number of others have the capability to produce and market them. The decision as to which companies LUBILOSA should approach depended on their ability to meet the following criteria:

- A small to medium-sized enterprise (<50 employees)
- Production capability that can be readily adapted to *Metarhizium*
- Access to donor funding
- An existing distribution system in appropriate regions
- Access to capital
- A track record in registering, producing, marketing and selling biopesticides
- Willingness to enter into an appropriate licensing agreement.

Basis of LUBILOSA Collaboration with Commercial Companies

Prior to entering into any discussions with commercial companies, confidentiality agreements were signed to protect LUBILOSA intellectual property. Licensing agreements were negotiated on the basis of the following:

- A non-exclusive basis incorporating a specific geographical, pest species or cropping system jurisdiction
- Transfer of liability
- An advance payment (licence fee) – scale dependent on company and royalty
- A royalty payment in the range 2.5–7.5%
- A non-assignable agreement and acceptable accounting procedures.

In turn, LUBILOSA provides the commercial company with:

- Toxicological and ecotoxicological information relevant to, but not necessarily wholly inclusive of, requirements for registration of the product.
- Relevant efficacy data and results
- Know-how and expertise to assist in the production process, registration, labelling and marketing of the product.

The IPR transfer agreement and the licensing agreement with a commercial company included clauses to safeguard the interests of the donors, in particular with warranties with regard to acknowledgement of the donors and their statutory obligations, and product liability and use. The licensing agreement between CABI and the commercial

company includes clauses that reflect the requirements of these warranty and liability statements.

Access to Benefits Arising from LUBILOSA

A large number of agencies and organizations have participated in and contributed to the development of the LUBILOSA mycoinsecticide. It is essential that every effort is made to ensure the adoption of this technology by relevant groups in Africa. At the same time an appropriate mechanism is required to distribute the benefits arising from the technology in accordance with the Convention of Biological Diversity (CBD).

Benefits arising from the development of the mycoinsecticide include:

- Access to the technology and the environmental, economic and social benefits that accrue from its use
- Capability building through the LUBILOSA training programme
- Royalties generated from sale of the mycoinsecticide.

The licences issued to the companies include clauses that ensure the following conditions apply:

- Good commercial practice with recourse to the appropriate transfer of public sector technology to the commercial sector
- Reasonable price charged for the sale of the product; the price must be competitive with other similar products to ensure general use and accessibility
- Reasonable availability of the mycoinsecticide within sponsor core countries requiring such products
- Monies generated from the commercial exploitation of the mycoinsecticide shall be credited to a Trust Fund and used in accordance with the declared objectives of the Fund for disbursement within Africa.

Royalties will be generated by the sale of the bioinsecticide but the amounts of money generated are unlikely to be large. If these royalties are split between all the agencies and organizations involved in the LUBILOSA Programme, then the amounts paid to each will be insignificant and of little practical value. For this reason, it was proposed that the money generated from royalties on the sale of the bioinsecticide in Africa be accrued in a Trust Fund. The purpose of the Trust will be to support collaborative initiatives associated with promoting biopesticides development in Africa.

The Trust Fund document specifies the purposes and principles of disbursement, the Trustee and powers, the Trust account, duration and taxation issues.

Recommendations

Some recommendations on the development of biopesticides are:

- Define at the outset of each development assistance R&D project whether a product will result from project outputs. Where this is the case consider:
  - Implications for exploitation
  - Non-commercial and commercial routes available
  - Market potential of the expected product

  - Need for commercial advice and input
  - Potential links with commercial companies.

- Ensure each partner in a project establishes and agrees to a publication policy and scrutinizes all R&D outputs to identify commercially exploitable know-how.

- Ensure that all information that is not required to commercialize the product is made freely available.

- Standardize Material Transfer Agreements (MTAs) based on the CGIAR (Consultative Group for International Agricultural Research) germplasm exchange MTA but with appropriate modification for the possibility of a subsequent commercial implementation route.

- Establish the principle of confidentiality agreements as part of the collaborative process between all partners.

- Engage commercial companies as early as possible in the product development process.

- In multi-donor projects, thought needs to be given in the first year as to how the IPR issues should be dealt with. Multi-sponsor agreements provide a relatively simple solution to the problem.

- Identify and establish clear unequivocal mechanisms for the disbursements of benefits arising from commercial exploitation which should include research collaboration, access to the final product and monetary benefits derived from its licensing and sale.

Discussion

Comment
Patenting of formulated biopesticides is alright but the patenting and storage conditions should be something that is suitable for the public.

Response
The storage patenting is done before the researcher enters into an agreement with the commercial firm that would trade in it.

Question
What is the use of withholding information even after applying and obtaining patent rights?

Answer
To ensure that the production, marketing and selling is done by commercial company with whom LUBILOSA programme has signed a secrecy agreement as well as a licensing agreement. This ensures that LUBILOSA's intellectual property rights are protected, the liabilities are transferred to the commercial company which in turn has to remit royalties as well as pay annual licensing fee so the secrecy agreement ensures that only one commercial company derives direct benefits, besides LUBILOSA programme.

Registration in Africa

Botanical Pesticides and Registration Requirements

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Abstract

Botanical insecticides are natural insecticides of plant origin and include pyrethrum, rotenone, neem, garlic, ryania, sabadilla, etc. Pyrethrum which has been in use for over 100 years is described in this paper. Registration of botanicals is important before use in order to ensure efficacy and safety to users and the environment, and to legalize their use. The registration process should involve product development, application to Pest Control Products Board (PCPB) and validation tests. Special treatment should be given to these classes of chemicals as far as safety is concerned due to their naturally known safety profiles.

Introduction

Botanical insecticides refer to natural insecticides of plant origin. These include pyrethrum, neem, rotenone, garlic, ryania, sabadilla, nicotine, etc. A typical example is pyrethrum that has been widely used for over a hundred years. It is derived from flowers of a daisy-like Compositae plant, *Chrysanthemum cinerariefolium*. The active ingredients in the flowers called 'pyrethrins' refer to six distinct insecticidal components which determine its unique properties; these include rapid action, lack of persistence, low mammalian toxicity and a flushing out effect. Mode of action is by contact and brings about effects on the nervous system. Pyrethrum is a broad-spectrum insecticide used against pests in public health, animal health, agriculture and stored products.

Pyrethrum was first introduced in Kenya in 1928 from Europe and, by 1933, the first commercial crop was exported mainly to Europe. Kenya pyrethrum was of high quality and hence quickly replaced the Japanese pyrethrum on the world market by 1941. Currently Kenya is the largest single producer of pyrethrum in the world accounting for over 70 per cent of the world market. Other producer countries are Tanzania, Uganda, Rwanda, Ecuador, Papua New Guinea and lately Tasmania in Australia. Pyrethrum grows well at altitudes above 6,500 feet with best flowering achieved at 7,000 feet above sea level. It also requires minimum rainfall of 750 mm well spread over the season and soils that are rich in phosphorus, calcium and magnesium with a minimum soil pH of 5.6.

Composition of Pyrethrins

Pyrethrins are naturally occurring organic esters formed by the combination of two carboxylic acids and three ketone alcohols (Table 1).

Table 1: Ketone alcohols and acids occuring in pyrethrins

Ketone alcohols	Acids	
	Chrysanthemic	*Pyrethric*
Pyrethrolone	Pyrethrin I	Pyrethrin II
Cinerolone	Cinerin I	Cinerin II
Jasmolone	Jasmolin I	Jasmolin II
	Pyrethrin I fraction	Pyrethrin II fraction

The esters of chrysanthemic acid, pyrethrin I, cinerin I and jasmolin I, together form the pyrethrin I fraction while the esters of pyrethric acid, pyrethrin II, cinerin II and jasmolin II, represent the pyrethrin II fraction. These six components together account for the kill and knockdown properties of pyrethrum extract.

Properties of Pyrethrum

The six distinct insecticidal components have outstanding properties that are unmatched by any other man-made insecticides.

- **Rapid action**: Direct application of pyrethrins on insects causes agitation, which leads to immediate paralysis, knockdown and death.

- **Low mammalian toxicity**: Pyrethrum is non-toxic to warm-blooded animals, as the pyrethrins are hydrolysed into polar metabolites in the gut and are quickly excreted. Pyrethrins are safely used in the control of household pests, in food-processing plants, restaurants and in hospitals. They have also been applied on young animals without any adverse effects recorded once ingested.

- **Lack of persistence**: In the environment, pyrethrum is degraded by a combination of sunlight and air, and hence presents few of the hazards usually associated with other persistent insecticides. Due to this, pyrethrins can be used in sensitive areas such as near foodstuffs, and in hospitals, restaurants and water treatment reservoirs.

- **Lack of insect immunity**: There are not many practical cases of resistance recorded. Resistance has been noticed only in populations under research where pressure of insecticide is exerted.

- **Broad spectrum of activity**: When pyrethrum products are used correctly and in accordance with specific instructions, they can be targeted to eliminate many different insect pests in different environments such as households, animal health and public health, and in agriculture.

- **Repellency**: Pyrethrin repellency is a strong tool in the management of the insects that are troublesome to human and animal health. Synergised pyrethrins are 2.2 and 5.0 times more repellent than allethrin and tetramethrin respectively. Pyrethrins are even more repellent than DEET (diethyltoluamide), a standard synethetic repellent which is effective at 4 µg/litre compared to pyrethrins at 0.25–0.5 µg/litre in the control of flies.

- **Flushing action**: Pyrethrum has the unique ability to flush insects out of their hideouts into the open, where they get into contact with a lethal dose of the insecticide.

Mode of Action

Pyrethrin-based products act by contact. Pyrethrins get into the insect through the cuticle and find their way to the tracheal system. The most vulnerable regions are the head and ventral prothorax.

The rapid knockdown is as a result of rapid penetration to the central nervous system sites, which bring about agitation, excitation, confusion and instability (random movement). Paralysis eventually results and the insect dies. In the resistant strains slow knockdown is observed due to slow entry of pyrethrins.

Use Areas

Pyrethrins, being broad-spectrum, can be used in the following areas:

a) Public health
   - Mosquito control
   - Fly control
   - Bedbug control
   - Lice control
   - Flea control

b) Animal health
   - Tick control
   - Fly control
   - Flea control

c) Agriculture
   - Pests of vegetables, fruits, flowers, ornamentals

d) Stored products
   - Grains
   - Hides and skins
   - Tobacco
   - Fish.

Product Registration

This is an important area as far as chemicals are concerned.

Objectives of Registration
- To ensure proper performance of the product
- To ensure safety to users and the environment
- To legalize the use of the products.

Registration Process
1. Product development research (data generation)
   - Develop a research proposal on particular problem area

- Carry out the intended research both in laboratory and field with correct designs and layouts, replications, controls
- Collect and analyse data with acceptable statistical tools
- Make inferences (effective or not).

2. Application to PCPB for new product introductions; develop and present a dossier to PCPB with the following information:
   - Efficacy data on previous and current work
   - Details on product
   - Description (trade name)
   - Function (insecticide etc.)
   - Intended use
   - Target pest
   - Formulation (EC, WP etc.)
   - Methods of use
   - Active ingredients
   - Chemical name, structural formula, mode of action etc.
   - Toxicology (acute LD_{50}, inhalations, oral LD_{50}, dermal LD_{50} etc.)
   - Environmental effects i.e. toxicity to bees, aquatic, persistence etc.
   - Physical state
   - Colour, boiling point, flash point, pH etc.

3. Validation tests by PCPB
   This is done by accredited testers (bodies) to confirm efficacy. The tester writes a confidential report to PCPB and, if positive registration is granted, at a fee.

Registration Requirements for Botanicals – Proposals

1. **Harmonization**: All botanicals should be treated equally.
2. **Safety**: Safety profiles of botanicals have been known naturally – and better known through testing. To subject them to too many toxicological needs as synthetic chemicals is not necessary.
3. **Rules of classification**: Different classes of chemicals should have their own rules and not be generalized. This should include EPA, FAO and WHO classifications.
4. **Testing centres**: More accredited testing centres are needed for faster work in the specific use areas and to provide checks and balances to the existing bodies e.g. the following should be considered in addition to the existing ones:
   - KARI – Muguga, Centre for Veterinary Research in Tick Control
   - ICIPE, KEMRI, in vector biology and others.

   However these bodies should meet the requirements for accreditation.
5. **Education**: Education on use of botanicals should be enhanced by all stakeholders in order to sensitize users on their importance.
6. **Accreditation**: PCPB should accredit relevant institutions for toxicological studies.

Discussion

Question
Is it true that most pesticides in Kenya are sold without full registration?

Answer
There are 350 pesticides with full registration and 150 with temporary registration.

Question
Are growers using pesticides commercially, which only have temporary registration?

Answer
Yes.

Question
Does that mean that 50% of the chemicals used in Kenya have not received full registration?

Answer
Yes.

Regulatory Guidelines for Mass-Produced Parasitoids and Predators: A Case Study of *Trichogramma* and Recommendations for Kenya

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Abstract

The commercial mass production of entomophages (parasitoids and predators) is becoming popular in many developing countries like Brazil, Colombia, South Africa, Indonesia and India. Interest in utilizing these biocontrol agents is also emerging in Kenya, especially due to the special needs of the horticulture industry. These agents, also referred to as 'macrobials', are not at all included under pest control products that are subject to registration requirements globally. However, guidelines are adopted for regulating their identity, source, quality, bioefficacy and biosafety. It is recommended that a sample of the agent be deposited in authorized repositories along with documentation on identity and source. The model of the most widely mass-produced macrobial natural enemy in the world, *Trichogramma* egg parasitoid, is presented as a case study. The parameters and standard methodology for identity, bioefficacy, biosafety and product quality are illustrated. For routine quality monitoring, the parameters include per cent parasitized eggs and those from which the progeny adults emerge. For additional and internal quality checks, per unit parasitism, total progeny, adult longevity and sex ratio are considered adequate. Based on the scenario elsewhere and the experience gained as well as data so far generated locally, recommendations are made for guidelines under the Kenyan situation for regulating the identity, quality, bioefficacy and biosafety of macrobials.

Introduction

The utilization of entomphagous arthropods has been an important tradition among farmers for a long time, dating back several thousand years, as in China and Yemen, where ants and spiders were utilized in agricultural pest management. The successful introduction of a parasitoid for biological-based pest management was made in 1833 when *Cotesia glomerata* Linnaeus was moved from England to USA. Globally, the development of biological control has followed no master plan but surged on, based on insight, luck, personal endeavour and institutional momentum (Singh *et al*., 2001).

Augmentation biocontrol includes 'inoculation' (periodical release in short-term crops), where multivoltine pests occur (e.g. release of *Rodalia iceryae* Janson for managing the

coffee margarodid) and 'inundation' (periodical release of large numbers, like *Trichogramma*, for control of lepidopteran pests in cotton and vegetables) to obtain immediate control effect (Murphy, 2001a). While '*Trichogramma* farming' was conceived more than a century ago, commercial-scale use has been undertaken in China in the 1950s (Wang *et al.,* 1988); the first private commercial producer in the USA was established in 1968 (Van Dreische and Bellows, 1996). In the last two decades, augmentation biocontrol has become standard practice for pest management in horticultural crops in Europe and North America (Zhou, 1988). This status is attributable to: (i) pesticide resistance among pests, (ii) consumer demand for residue-free produce and (iii) the biocontrol technologies are by and large cheaper than conventional pesticide-based control (Van Lenteren, 1989; Van Dreische and Bellows, 1996). In the USA, *Trichogramma* spp. are being used as the key augmentation biocontrol agents for European corn borer on maize, fruit worm, cabbage looper and hornworm on tomato, codling moth on apple, as well as bollworm and cotton budworm on cotton (Wang *et al.,* 1988).

This paper focuses on the relevant regulatory practices governing commercial mass production in developing countries, and makes recommendations for Kenya by examining *Trichogramma* as a case study.

Commercial Production of Entomophages Worldwide

The apparent reasons for the popularity of the entomophages (parasitoids and predators), referred to also as 'macrobials', are: less laborious and more pleasant for application; no problem of residues and waiting periods; no phytotoxicity or operators' risks. In a review of the global scenario of mass production of biocontrol agents, Van Lenteren and Bueno (2003) have estimated the number of commercial producers in Europe (25), North America (20), Asia (15), South America (15), Australia/New Zealand (6) and South Africa (5). They also point out that public support facilities play a substantial role as in Colombia (>20), Cuba (>200), Mexico (30) and Peru (>20), as well as China. They estimate that mass-produced biocontrol agents accounted for turnover greater than US$25 million in 1997, US$50 million in 2000, with subsequent annual growth at 15–20 per cent.

The common mass-produced predators include lacewings (e.g. *Chrysopa*) (Sekirov *et al*., 1991), ladybird beetles (e.g. *Coccinella*), sucking bugs (e.g. *Orius*) and predatory mites (e.g. *Phytoseiulus*) (Murphy, 2001a). The mass-produced parasitoids include egg parasitoids (e.g. *Trichogramma*) (Smith, 1996; Sithanantham *et al.,* 2001) and larval parasitoids (e.g. *Cotesia*) (Guofa *et al.,* 2003). Examples of several mass-produced macrobials are provided in Table 1 along with field use guidelines in Table 2.

Regulatory Guidelines

Global Scenario

Guidelines for mass-produced macrobials, in general, apply to identity, quality, bioefficacy and biosafety. Murphy (2001b) reviewed the regulatory issues in augmentative biocontrol and pointed out that while governments are anxious to set quality criteria for mass-produced beneficial organisms, the processes and approaches should be pragmatic, so as to help the development of augmentative biocontrol.

Table 1: Examples of common mass-produced parasitoids and predators for biocontrol of arthropod pests in agriculture

Common name	Scientific name	Family	Order	Type*	Pest stage*	Pest group attacked
Trichogramma-tid	*Trichogramma chilonis*	Trichogramm-atidae	Hymenoptera	PA	E	Lepidoptera
	Trichogramma pretiosum	Trichogramm-atidae	Hymenoptera	PA	E	Lepidoptera
	Trichogrammat oidea bractrae	Trichogramm-atidae	Hymenoptera	PA	E	Lepidoptera
Scelionids	*Trissolchus*	Scelionidae	Hymenoptera	PA	E	Hemiptera
	Telenomus spp.	Scelionidae	Hymenoptera	PA	"	Lepidoptera
Braconids	*Chelonus blackburni*	Braconidae	Hymenoptera	PA	E/L	Lepidoptera
Ichneumonids	*Campoletis chlorideae*	Ichneumidae	Hymenoptera	PA	L	Lepidoptera
Tachinids	*Sturmiopsis inferens*	Tachinidae	Diptera	PA	L	Lepidoptera
	Eucelatoria bryani	Tachinidae	Diptera	PA	L	Lepidoptera
	Carcelia spp.	Tachinidae	Diptera	PA	L/P	Lepidoptera
Chrysopids	*Chrysoperla carnea*	Chrysopidae	Neuroptera	PR	E/L	Lepidoptera
Coccinelids	*Coccinella septempunctata*	Coccinellidae	Coleoptera	PR	N/A	Aphids
Hoverflies	*Ischiodon scutellaris*	Syrphidae	Diptera	PR	N/A	Aphids
Bugs	*Orius* spp.	Anthocoridae	Hemiptera	PR	N/A	Thrips
Mites	*Amblyseius* spp.	Phytoseiidae	Acarina	PR	N/A	Spider mites

*E = Egg; L = Larva; N = Nymph; A = Adult; P = Pupa; PA = Parasitioid; PR = Predator
Source: Lingappa *et al*., 2001

Quality standards have been actively developed in North Africa and Europe with several decades of support from the governments, which is reflected in their policy. In the early 1980s, steps were taken by the International Organization for Biological Control (IOBC) and the United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA/APHIS) by establishing IOBC working group (called the EC Concerted Action Group), focusing on the following:

i) Develop simple and reliable quality control methods
ii) Test the simplified quality parameters in commercial conditions
iii) Improve the practical use of the parameters and
iv) Monitor/implement quality control at production and product stages.

Table 2: Examples of dose rates of macrobials adopted/recommended in augmentation biocontrol in India

Crop	Pest	Biocontrol agent	Dose per application	Remarks
Tomato	*Helicoverpa armigera*	*Trichogramma* spp.	50,000 per hectare	Six releases at weekly intervals
Beans	*Tetranychus* spp.	*Phytoseiulus persimilis*	10 adults per plant	Once at one month after crop germination
Potato	*Agrotis* spp.	*Steinernema carpocapsae*	5 billion infective juveniles per hectare	Application in soil through irrigation water
Grapes	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzeri*	2500–3000 beetles per hectare or 10 beetles per vine	Release adults as soon as the mealy bug incidence is observed
Citrus	*Icerya purchasi*	*Rodalia cardinalis*	10 beetles per infested plant	Adopt ant suppression measures to assist
Apple	*Eriosoma lanigerum*	*Aphelinus mali*	1000 adults/ mummies per infested tree	Effective on aerial infestation; more impact in valleys than in slopes
	Cydia pomonella	*Trichogramma embryophagum*	2000 adults per tree	Release to start on first oviposition or moth catch; continue weekly
Coffee	Mealy bugs (*Pseudococcus/ Plenococcus*)	*Cryptolaemus montrouzeri*	2–10 beetles per infested plant	Adopt ant suppression measures to assist
Tobacco	Aphids (*Myzus* spp.)	*Chrysoperla* spp.	6 per plant	Release as second instar larvae in field crop
Cotton	Bollworm (*Helicoverpa/ Earias/ Pectinophora*)	*Trichogramma* spp.	150,000 per hectare	Six times, weekly, from early egg laying period

Source: Singh, 2001

The *Trichogramma* species used for the management of European corn borer (*Ostrinia nubilalis* Hübner) are assessed by a set of standard quality parameters. The quality control includes comparison of the original candidate agent (e.g. allozyme frequency/analysis) and measurement of indicative attributes (e.g. walking speed) (Bigler, 1994).

Scenario in Developing Countries Outside Africa

The mass production and wide-scale utilization of macrobials (entomophages) is currently popular in South America (e.g. Brazil, Colombia) and Asia (e.g. India, Indonesia). In these countries, the regulatory requirements are mostly limited to identity, biosafety (for exotic species) and product quality and there is no requirement for registering them as pest control products (Murphy, 2001b; Pawar, 2001).

The registration requirements applicable for other pest control products including microbials are not applicable to the macrobial agents/products. For instance, the mandatory product registration requirements under the Insecticides Act (1986) in India are extended to microbials, botanicals and pheromone products but not to entomophages (Pawar, 2001). This Act covers the import, manufacture, sale, transport, distribution and use of pesticides (insecticides, fungicides, weedicides, plant growth regulators and biopesticides) and the products require to be included in the 'schedule' under this Act. The Registration Committee constituted under this Act has also simplified the registration guidelines and procedures for all biopesticides and has facilitated their commercialization even during the currency of provisional registration. The Bureau of Indian Standards (BIS) prescribes the technical and formulation specifications for microbial biopesticides, while there is no such need for macrobials (Pawar, 2001). Parameters governing the quality of entomophages as products have been worked out and could be utilized in implementing quality control (Bigler, 1994; Ballal *et al.,* 2001). An illustration of quality parameters for macrobials is provided in Table 3.

Table 3: Macrobials: guaranteed minima for quality in India

Parameter	*Trichogramma*	*Chrysopa*
Per cent content	90% parasitism	85% hatch
	90% emergence	–
Progeny attributes	Sex ratio 1:1	N/A
Damage margin transit	N/A	15%
Progeny/Adult fecundity		
Optimum	50–60	400
Minimum	40	300

Source: Singh *et al*., 2001

Suggested Regulatory Guidelines for Macrobials in Kenya

Commercial production of macrobials in Kenya should be governed by simple guidelines that promote their full-scale utilization, while catering to the concerns of both the producers and the consumers. Provisional clearance (equivalent of but not the same as registration) may be granted on the basis of the following criteria:

1. **Identity of the agent:** Name of species (and strain) of the agent (including family, order), its source (host insect, host plant, location and collector) accompanied by a sample (specimen) deposited in the referral repository.
2. **Bioefficacy data from elsewhere:** Field parasitism, pest infestation level and crop damage (for the target pests) from any other country/region, if not readily available in Kenya.
3. **Product content quality:** Expected content of (live adult) parasitoids/predators per unit package should be indicated – and expected optimum (and minimum) quality standards (e.g. laboratory longevity, laboratory attack rates) for both parasitoids and predators.

Confirmed clearance may be given to the macrobials on the following criteria:

i) **Local bioefficacy data:** Include host specificity/preference/suitability (laboratory test) and field performance (for target pests with dose rates quantified).

ii) **Biosafety data:** Limited to exotic species/strains and only if reckoned (by experts' panel) as necessary to assess risks to economically/ecologically important non-target native species.

A suggested tier system of regulatory guidelines for macrobials in Kenya is provided in Table 4.

Model for Macrobial Regulatory Guidelines – *Trichogramma*

Background

Trichogrammatids (Trichogrammatidae; Hymenoptera) are minute wasps which are the most produced parasitoids (in numbers) globally. They are egg parasitoids and deployed mainly for managing lepidopteran (caterpillar) pests in agriculture and forestry. Hassan (1993; 1994) has estimated that over 10 million hectares of crops and forest trees are protected annually through the use of trichogrammatid egg parasitoids. The global use of *Trichogramma* for different crops is illustrated in Table 5.

The potential for utilizing egg parasitoids in biocontrol of lepidopteran pests in vegetable crops in Africa is well documented (Sithanantham *et al.*, 2001). In eastern Africa, a joint initiative is currently being implemented with four national partners – Kenya, Uganda, Tanzania and Ethiopia – for improved utilization of *Trichogramma* in managing *Helicoverpa armigera* in vegetable-based cropping systems (Sithanantham *et al.*, 2002).

In a recently held workshop on *Trichogramma* utilization in Kenya, the potential demand (Table 6), the factor in adoption (Table 7) and likely players in mass production and delivery (Table 8 and 9), were documented. It is also significant that private enterprises (e.g. Dudutech) are already investing on *Trichogramma* mass production in Kenya (Labuschagne, 2003).

Identity of Species Used

The identity of *Trichogramma* should usually be up to genus/species/strain level. Furthermore, the source crop/host plant and the host insect (pest) should be documented as well as the collector (institution). It is important to deposit reference specimens of the foundation stock to referral laboratories or repositories. At present, the gene bank for *Trichogramma* at the International Centre of Insect Physiology and Ecology (ICIPE) is equipped to be such a repository and to provide molecular characterization support (with PCR, AFLP) (Baya *et al.*, 2002). Therefore, there should be at least 20 adults stored in absolute alcohol for conventional as well as molecular characterization.

Table 4: Suggested tier system of assessment of requirements for biosafety, efficacy and quality for macrobials in Kenya

Requirements	Tier 1	Tier 2	Tier 3
1. Biosafety			
Step 1. Origin of the agent (species/strain)			
•Indigenous	Document A (identity)	N/A	N/A
• Exotic	—	Step 2	N/A
Step 2. Host range/potential suitability (lab test)			
• Agroecosystem (beneficial arthropods)	—	Document B (Lab tests)	N/A
• Biodiversity (endangered arthropod species)	—	N/A	Document C (Lab/Nethouse tests)
2. Bioefficacy			
Step 1. Specificity to original host and target host			
• Original host and target host both same (lab test – preference)	Document D	N/A	N/A
• Both are different (Lab test – suitability and preference)	—	Document E	N/A
Step 2. Field efficacy			
• Parasitism/predation rate	Results from elsewhere	Document F	N/A
• Pest numbers/infestation	Results from elsewhere	Document G	N/A
• Pest damage/crop yield	Results from elsewhere	Document H	N/A
3. Quality			
Step 1. Conform to numbers per unit (package)			
• Yes	Label	N/A	N/A
• No	N/A	Document J	N/A
Step 2. Conform to quality (longevity/other fitness parameters)			
• Yes	Label	N/A	N/A
• No	N/A	Document K	N/A

Document: Details provided

A Species/strains; order – family; collector; host/prey insect; crop; location

B Safety to other arthropods in the same niche and habitat (mainly parasitoids, predators, pollinators)

C Safety endangered arthropods (e.g. butterflies in forest boundary ecosystems)

D Original host and target host (paired choice test between lab. host and target host)

E Potential alternate host/prey in crop ecosystem (choice and no-choice tests with lab host/prey and target host/prey)

F Proportion of host/prey exposed and successfully parasitized/predated (lab study under optimal conditions)

G Pest numbers (counts per unit habitat – per plant , per branch, per stem, per leaf – as applicable

H Crop damage (visual rating for intensity of damage on a severity scale of 1–3/1–5/1–9; proportion of plants or plant parts damaged (as per cent); marketable yield per plant/plot row per m^2)

J Content: Proportion of parasitoids/predators emerging successfully per unit package (in triplicate sample)

K Quality: Parasitoids to be assessed by lab test on adult longevity/fecundity/movement; predators to be assessed for adult longevity and predation rate (per unit time) under optimum conditions; triplicate samples.

Table 5: Various crops and trees on which *Trichogramma* spp. were used for controlling insect pests in different countries (data pre-1991)

Crop/tree	Country
Corn	Former USSR, China (including Taiwan), Mexico, Philippines, Colombia, Bulgaria, France, Germany, Switzerland, USA, Italy, Austria, Former Czechoslovakia, Romania
Sugarcane	China (including Taiwan), Philippines, Colombia, Iran, Egypt, Cuba, India, Uruguay, Mexico
Cotton	Former USSR, USA, Colombia, Mexico, China, Iran
Tomato	Former USSR, China, Mexico, Colombia, USA
Cabbage	Former USSR, China, Bulgaria, The Netherlands, former Czechoslovakia
Apple	Former USSR, Bulgaria, China, Germany, Poland
Beet	Former USSR, Bulgaria, China
Rice	China, Iran, India
Soyabean	Colombia, USA, China
Sorghum	Mexico, Colombia, China
Pine	China, Bulgaria
Vine	Former USSR, Bulgaria
Forage grass	Former USSR
Cayenne pepper	China
Tobacco	Bulgaria
Wheat	Former USSR
Citrus	China
Avocado	USA
Spruce	Canada
Olive	Tunisia
Plum	Bulgaria
Stored products	USA

Source: LI-Ying Li, 1991

Table 6: Expected adoption rate of trichogrammatid egg parasitoids as pest management agents in different target crops over different periods in Kenya*

Target crops	Visualized per cent adoption of trichogrammatids in Kenya over time		
	2 Years	5 Years	10 Years
Vegetable crops	28%	53%	67%
Cotton	26%	44%	69%
Cereals	27%	39%	51%

* Based on stakeholders' workshop and expert task team assessment (November 2002; ICIPE – unpublished)

Table 7: Factors perceived to influence the adoption potential of *Trichogramma* in Kenya*

Factors	Individual score frequency§					Average score	Percentage responding (%)
	A	B	C	D	E		
1 Extent of awareness of usefulness	16	-	–	–	–	4.0	100
2 Extent of relative efficacy in control compared to pesticides	8	8	–	–	–	3.5	88
3 Extent of cost-benefit (economics)	11	5	–	–	–	3.7	93
4 Ease of handling/use	6	10	–	–	–	3.4	85
5 Local availability/delivery	10	6	–	–	–	3.6	90

*Based on stakeholders' workshop and expert task team assessment (November 2002; ICIPE – unpublished)
§ Scores and grades: A = Very promising (4); B = Promising (3); C = Just promising (2); D = Not promising (1); E = Not decided (0/omitted)

Table 8: Projected involvement of various sectors in mass production of *Trichogramma* in Kenya*

Sectors	Individual score frequency§					Average score	Percentage (%)
	A	B	C	D	E		
1 Private enterprise	11	4	1	–	–	3.6	90
2 Development institutions (HCDA/FPEAK)	5	9	2	–	–	3.1	78
3 Community based organizations (CBOs)	6	6	4	–	–	3.1	78
4 Non governmental organizations (NGOs)	6	5	5			3.1	78
5 Farmers' cooperatives	3	5	6	2	–	2.6	65
6 Agro-input retailers	3	5	4	4	–	2.4	60

*Based on stakeholders' workshop and expert task team assessment (November 2002; ICIPE – unpublished)
§ Scores and grades: A = Very promising (4); B = Promising (3); C = Just promising (2); D = Not promising (1); E = Not decided (0/omitted)

Table 9: Projected involvement of various sectors in the delivery systems of *Trichogramma* in Kenya*

Sectors	Individual score frequency§ A	B	C	D	E	Average score	Percentage (%)
1 Agro-input retailers	2	7	2	–	–	3.0	76
2 Community based organizations (CBOs)	3	5	3	–	–	3.0	76
3 Non governmental organizations (NGOs)	4	4	2	–	–	3.0	76
4 Farmers' cooperatives	2	6	3	–	–	2.9	73
5 Private enterprise	1	7	3	–	–	2.8	71
6 Development institutions (HCDA/FPEAK)	1	3	7	–	–	2.5	64

* Based on stakeholders' workshop and expert task team assessment (November 2002; ICIPE – unpublished)

§ Scores and grades: A = Very promising (4); B = Promising (3); C = Just promising (2); D = Not promising (1); E = Not decided (0 / omitted)

Biosafety Guidelines

It is important that non-target risk assessment be limited to what is appropriate to the needs of the developing country (Sithanantham, 2003; Muholo *et al*., 2003). This is needed only for exotic species/strains and should simplified, rather than the more complex set of criteria being suggested, based on the European scenario (Van Lenteren *et al*., 2003).

In the case of Kenya, the risk assessment requirements will apply to:

i) Possible hybridization with native species, leading to erosion of the native gene pool among Kenyan trichogrammatids (to be monitored in laboratory mating/progeny studies)
ii) Competitive displacement of other native egg parasitoid species in Kenyan habitats (to be assessed in laboratory and field cage studies)
iii) Risk to endangered (in biodiversity terms) native fauna, like butterflies in forest-boundary farming areas, and where butterfly farming is being practised.

Bioefficacy Assessments

The criteria for bioefficacy assessment include specificity/preference/host range as well as host habitat interactions in the field performance of the parasitoids.

- **Laboratory studies**

Trichogrammatid species/strains vary in their specificity and are also more 'habitat-responsive' (host plant effect) (Smith, 1996). It is therefore important to assess the preference at strain level (below species level) for the target pest (by paired choice test with alternative potential pest lepidoptera) that could be expected to occur in the major cropping systems. For this purpose, since the Kenyan farming situation is one of multiple/mixed cropping, the following candidate hosts should be included for comparison in the laboratory tests:

i) **Laboratory host**: *Corcyra* or *Ephestia* or *Sitotroga* or *Plodia*
ii) **Pest hosts**: *Helicoverpa armigera, Plutella xylostella, Chilo partellus, Sesamia* or *Busseola*.

Laboratory tests with the candidate hosts should include the following:

a) **Host suitability**: Record the percentage eggs parasitized; percentage parasitized (blackened) eggs from which progeny adults emerge; sex ratio of the progeny (under no-choice situation; with 8–10 replications each; using a group of 3–5 adult females per replication).
b) **Host preference**: Compare between target host and each of the other standard hosts (at least three from pest hosts plus one laboratory host; as paired choice test with eggs glued to small bits of cards and exposed for 12–24 hours; other details same as for the host suitability studies above).
c) **Host plant role:** Repeat the test with potted plants on which the target pest is present on target crop and compared with the comparison host (pest) on their natural host. This will avoid over- or under-estimates of the potential for the egg parasitoid in focusing on parasitizing the target pest.

- **Field efficacy assessment**

i) Field testing guidelines

- Select the most optimum site/season where the crop growth is likely to be good and the natural pest infestation levels are likely to be adequate; where 'hot spots' are known, they should be preferred; where facilities exist, try to enhance the infestation through release of laboratory reared target pests, or through spreader rows (planted early, around/within the plots).
- Plant two plots (of about 50 x 50 m) of the target crop with a buffer zone (of about 50–100 m) in between, all under the same crop management and without pesticide sprays, as far as possible.
- Divide the 'release' and 'no-release' plots into grids of sub-plots of 5 x 5m each; keep the centre of each such sub-plot as the release point (in release plots).
- Release the adults (by tagging cards) to adjust to the field release dose (in most short-term crops the release rates are 50–150 thousand wasps per hectare).

ii) Field parasitism

Collect either naturally laid eggs in the crop or keep sentinel (laboratory reared) eggs on the crop; collect them for sampling at 2–3 days after *Trichogramma* release from both the plots; collect at least 10 sets (replicates) of 50–100 eggs from each plot (both release and no-release); work out the number of parasitized (blackened) eggs and their ratio to the total (as percentage parasitized eggs). Repeat the same type of sampling after each release (generally 3–6 weekly releases are likely) during the reproductive stage of crops for pests like *H. armigera*; additional releases may be required for pests like stem borers or diamondback moth.

iii) Pest infestation levels

Since *Trichogramma* attacks the egg stage, it is appropriate to assess the impact on the resulting larval stage. The number of larvae (mostly grouped as small/medium/large)

may be recorded at two weeks after *Trichogramma* release; where the pests are concealed (bollworms, stem borers), destructive sampling (about 20 plants/plot) should be undertaken.

iv) Crop damage and yield

The damage to the crop by the larval (caterpillar) stage may be assessed either as percentage plants or plant parts damaged or by adopting a severity scale (1–5 or 1–9) for visual scoring. The damage parameter(s) should reflect both 'distribution' and 'intensity' of pest damage. The crop yield should be based on marketable quality of yield, per unit area or per plant (average).

v) Field efficacy evaluation – precaution

As far as possible efforts should be made to minimize interference from extraneous factors in estimating the effects on parasitism/host numbers/crop damage/yield. For instance, prevention of interference by crop diseases should be considered. Wherever possible, preventative treatments could be applied for 'likely' diseases. Sprinkler irrigation may affect the activity of parasitoids and/or the retention of the host eggs on the plant. So, wherever possible, alternate irrigation methods should be considered, so as to minimize interference.

Quality Parameters

Bigler (1994) has reviewed the different steps in the *Trichogramma* mass production system where quality is routinely monitored (Figure 1) and also the relevant aspects/attributes relating to laboratory and field performance parameters (Figure 2). The nature of quality control that is commonly adopted in such production systems is illustrated in Figure 3 (Figures 1–3 are at the end of the paper).

Quality attributes that are important for government guidelines for regulation of the following two attributes would be adequate for Kenya:

i) **Content per pack**: This represents the number of live individuals (adults) that are expected to emerge per unit pack. Usually for *Trichogramma,* the host eggs are distributed on cards of varying dimensions. The expected number of adult wasps is a function of the number of blackened (parasitized) eggs and those among the black eggs from which the progeny adults emerge. In a host with small eggs (like *Corcyra/Ephestia/Sitotroga*), 12–16 thousand eggs may measure up to one millilitre by volume. Based on the quantities of host eggs and the parasitized eggs sampled, it is possible to predict the expected adults per unit. Usually the black eggs should be about 90 per cent and the percentage emerged black eggs should be about 90 per cent. However, commercial producers generally overdose the host eggs (by 10–30 per cent), to ensure that the minimum content declared is kept up.

ii) **Fitness of resulting adults**: The productivity of the resulting adults is determined by the parasitism rate/fecundity, progeny production capacity and also the progeny sex ratio. For assessing these attributes, triplicate samples of at least 100 host eggs are to be cut and kept in vials for emergence. From each card, a set of five females are removed after one day (allowance for mating) and the rest counted after a week into males and females to work out ratio of females. It should be at least 50 per cent females, on average, among the triplicate samples. The five adult females are retained with 150 eggs for a period of 24 hours. The cards are then

removed and kept for recording the blackened and emerged eggs after two weeks. The average progeny produced per female should be at least 15 adults. This will ensure that the *Trichogramma* adults can be expected to make satisfactory impact on the pest. There are other criteria recommended by the IOBC and other researchers. Based on local experience, however, this appears to be a satisfactory guideline for adoption by monitoring agencies in the Kenyan situation. In case these guidelines are to be reviewed, experts from locally based institutions (KARI, JKUAT and ICIPE) could provide suitable scientific input.

Conclusions

It is evident from the global scenario that the vigorous regulations applicable to chemical pesticides should not be extended to biopesticides, as the latter are still being developed – although they are known to be safer to the ecosystem, operators and consumers of the crop they produce. In principle, macrobials should be exempt from routine registration requirements, as is the practice globally. It is important that any regulatory guidelines governing local large-scale commercial production and use of macrobials are minimal and supportive, instead of extensive and inhibitory. It should be borne in mind that the Kenyan horticulture industry is required to urgently shift to more intensive use of biopesticides, and every effort must be made to promote their mass production and utilization. The regional *Trichogramma* gene bank and quality control laboratory at ICIPE could provide the back-up and training for species/strain characterization of accessions deposited in the repository as well as in quality control. Biopesticide producers should be subject to 'softer' regulations, as they invest on products which provide relatively less turnover compared to chemical pesticides, and their motivation to continue or strengthen their investment in biopesticides should be maintained through supportive and enabling policy and regulatory environments. The guidelines should be based on the needs for harmonizing and catering to the concerns of the producers and consumers alike.

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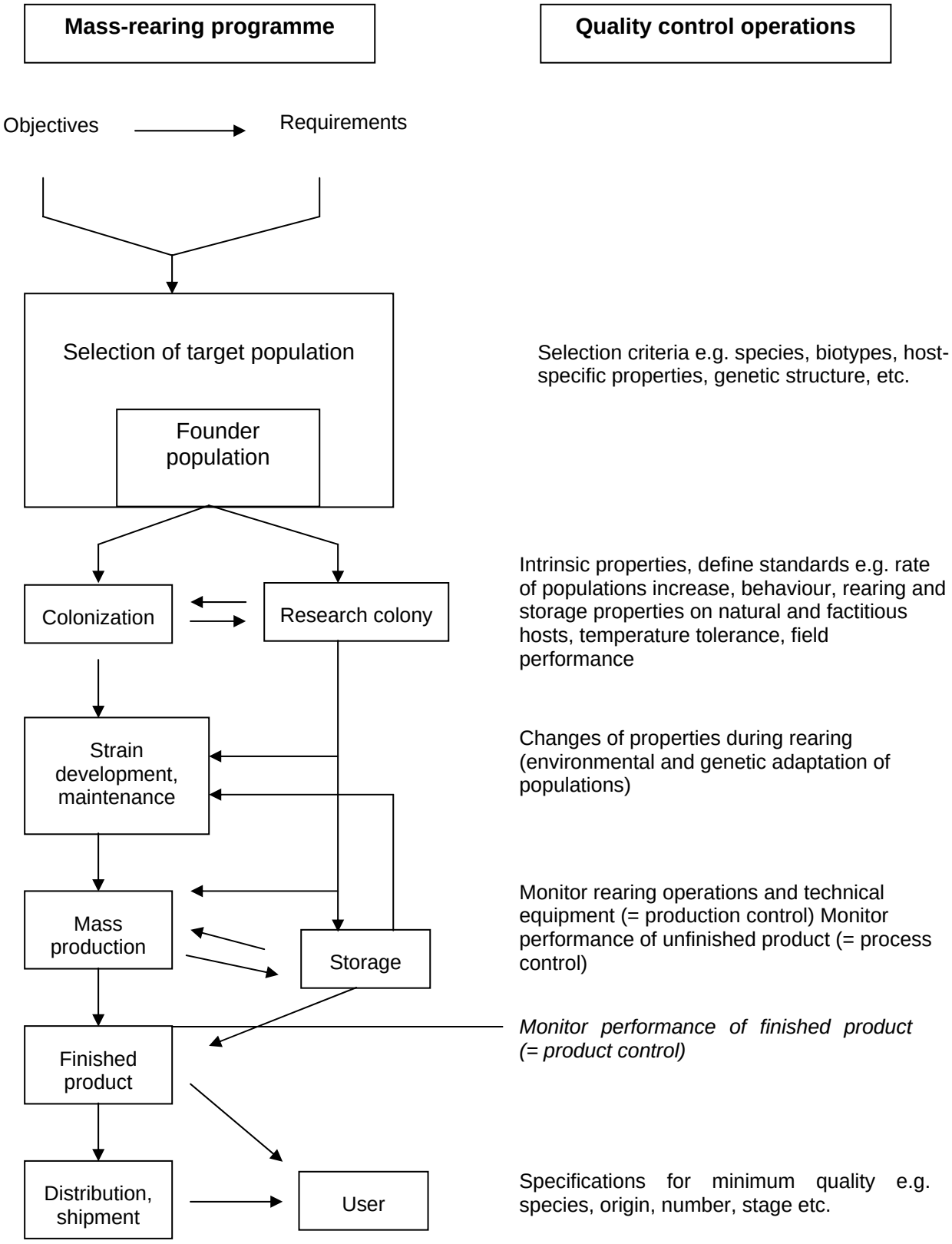


Figure 1. ***Trichogramma*** **mass-rearing programme and routine quality control operations**
Source: Bigler, 1994

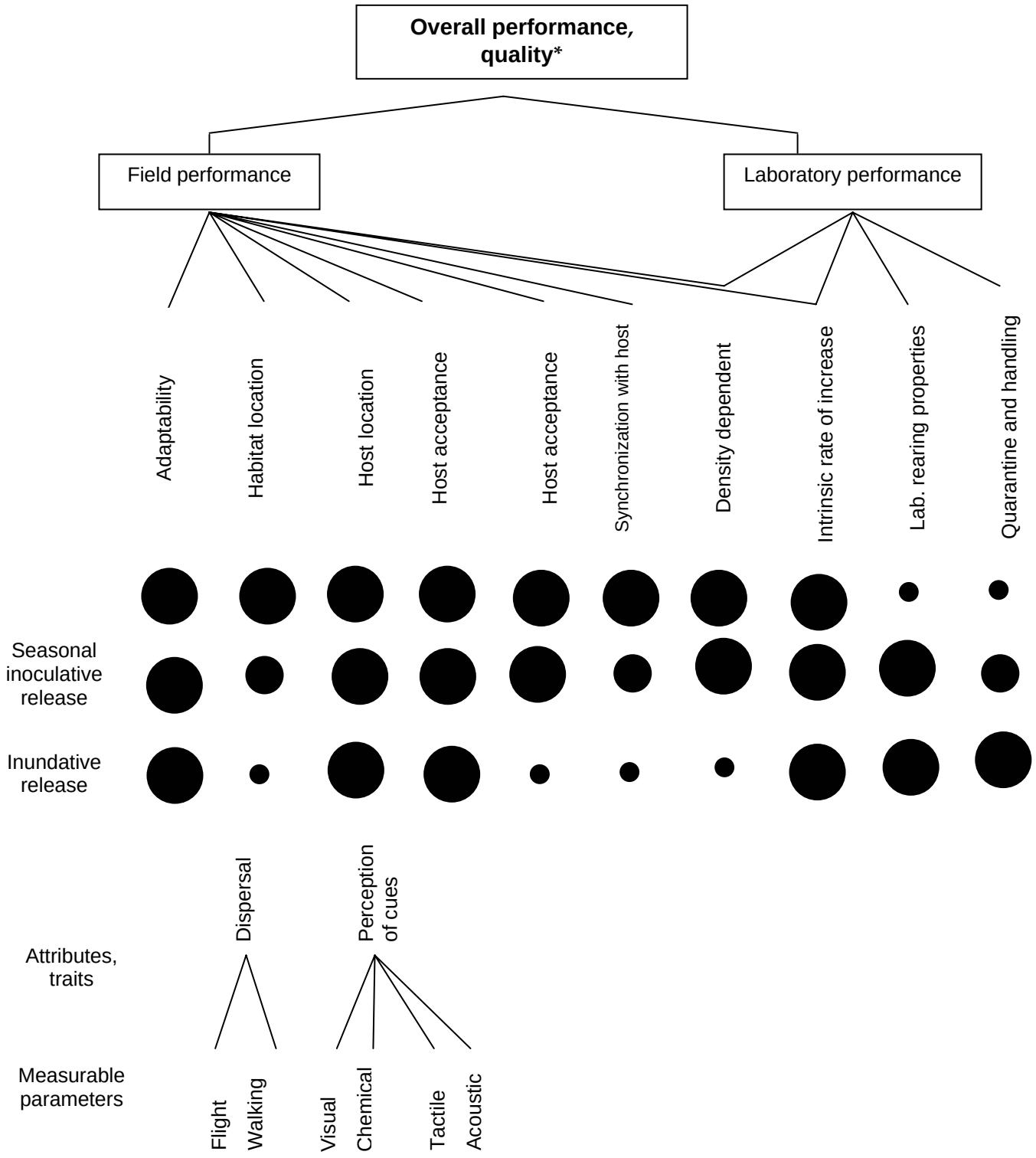
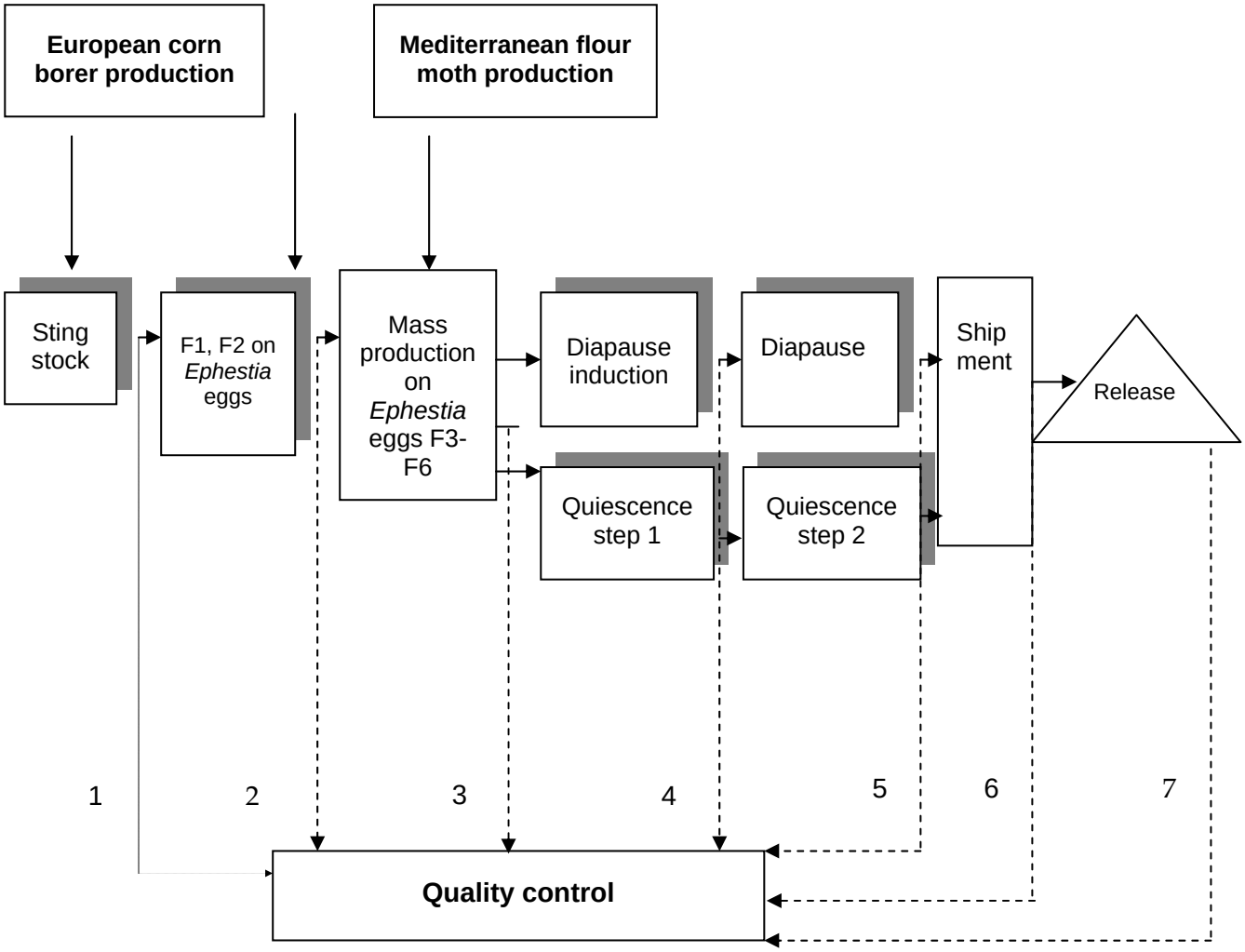


Figure 2. Relative importance of quality components in relation to the objective of *Trichogramma* production and use*

Source: Bigler, 1994

*The size of each black circle is proportional to the importance of each trait.



Sting stock	Host acceptance Locomotion (walking) Fecundity Longevity Percentage parasitism in field	Once a year
F1, F2	Host acceptance Host suitability Walking speed Percentage females Fecundity Longevity	Once a year
F6 (no storage)	Percentage parasitism Percentageemergence Percentage females	Each batch
Diapause induction and quiescence (step 1)	Percentage parasitism	Each batch
Diapause and quiescence (step 2)	Percentage emergence Percentage females Fecundity Longevity Walking speed	Each batch
Shipment (transport to user)	Percentage black eggs per release unit Percentage emergence Percentage females No. of females per release unit	Each shipment
Release	Percentage parasitism in field	Once a season

Figure 3. Importance of strain improvement for sustaining impact of mass reared *Trichogramma* case study*
Source: Bigler (1994); * Switzerland during 1975–90 on *Ostrinia* egg

Discussion

Comment
It is possible to harmonize conflict of interest between biopesticides and chemical pesticides, both at policy and regulatory levels, but also at operational level by integrating their use in compatible and selecting deployment.

In meetings the concerns regarding fear of interception of export horticulture products. The recent workshop converted jointly by KEPHIS, KFC and FPEAK has recognized steps like identification and preventatives field practices. To minimize risks of interception – the key risk being *Helicoverpa* and *Liriomyea*, Besas, whiteflies, fruit flies and thrips.

Kenyan Regulations for Importation of Biological Control Agents

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Abstract

Increased concern regarding contamination of the environment in the recent years has resulted in critical re-evaluation of the methods used in plant protection and has led to increased demand for biological pest control. To ensure that Kenya benefits from the use of biocontrol agents, the Government has put up a regulatory mechanism which assures the integrity of the environment. The Kenya Standing Technical Committee for Imports and Exports (KSTCIE) operates under Cap 324 of the Laws of Kenya and considers applications for importation of plant products, exotic biological control organisms, seeds, biopesticides and other regulated products. After importation is approved, the Kenya Plant Health Inspectorate Service (KEPHIS) issues the biological import permit and ensures strict adherence to the conditions spelled out by KSTCIE. The safety measures applied during importation are in compliance with Interim Commission of Phytosanitary Measures (ICPM) No. 3 (guidelines on importation of exotic biological control organisms). There is need to review the existing regulations to include clear guidelines on importation, manufacture, registration, distribution, use and exportation of biocontrol agents.

Introduction

Increased concern regarding contamination of the environment in the recent years has resulted in critical re-evaluation of the methods used in plant protection. This situation has resulted in a search of alternative pest control methods and has led to an increased demand for biological pest control. To ensure that Kenya benefits from the use of biocontrol agents, the Government has put up a regulatory mechanism, which assures the integrity of the environment. To simplify this process the key points are highlighted in this paper.

Regulations Governing Importation

The Kenya Standing Technical Committee of Imports and Exports (KSTCIE) operates under Cap 324 of the Laws of Kenya, 1982, and enforces regulations governing importation of all crop protection agents, including plant products, exotic biological control organisms, seeds, biopesticides and other regulated products.

The committee performs the following functions:

- Advises on the best ways and means of implementing the provisions of the law relating to importation of biological control organisms and biopesticides, among other agricultural products, for the purpose of essential scientific research, experiment, education or commercial production.

- Considers applications for importation of plant, plant products, biological control organisms, genetically modified products, seeds, biopesticides, not otherwise eligible for importation under Cap 324.

Meetings of the committee are convened by the secretariat in consultation with the Director of Agriculture and Livestock Production.

Procedures for Importation

The following procedures are required:

- Importer makes an application to KSTCIE for the agent to be imported.
- The importer is then advised on the requirements (e.g. dossier and containment facilities).
- The importer provides the dossier for review by KSTCIE and the containment facilities are inspected by Kenya Plant Health Inspectorate Service (KEPHIS). The safety measures applied are in compliance with Interim Commission of Phytosanitary Measures (ICPM) No. 3 (guidelines on importation of exotic biological control organisms).
- The applicant is invited by the KSTCIE to defend the request.
- The application may either be approved or rejected.
- If conditions are met, an import permit is issued to the importer by KEPHIS, which ensures strict adherence to the conditions spelled out by KSTCIE.
- The importer should inform KEPHIS about the day of arrival of the biological control agent so that an inspector may accompany the consignment to the confinement facilities for inspection.
- In case the importer wants to release the biological control agent into the field, he/she must apply for another permit.

Evaluation Criteria

Evaluation criteria are:

- Successful use of the biocontrol agent elsewhere
- Specificity of the biocontrol agent
- Risk assessment
- Risk management and control options.

Biological Control Agents Approved by KSTCIE

The following are approved for importation:

- *Telenomus isis*
- *Niphographata olbiguttalis*
- *Beauveria bassiana*
- *Phytoseilus persimilis*
- *Steinernema feltiae*
- *Cotesia (Apanteles) flavipes*
- *Xanthopimpla stemmator*
- *Sturmiopsis inferens*
- *Diadegma semiclausum*
- *D. mollipla*

- *Psyttalia concolor*
- *Cotesia chilonis*
- *Cordyceps* sp.
- *Metarhizium anisopliae*
- *Cales noacki*
- *Neohydronomus affinis*
- *Neozygites tanajoa*
- *Cyrtobagous salviniae*
- *Diglyphus isaea*
- *Feltiella acarisuga*
- *Trichogramma* sp.

The following are approved for export:

- *Phytoseilus persimilis*
- *Diglyphus isaea*
- *Encarsia formosa*
- *Amblyseius californicus*

Conclusion

With the increasing demand and awareness of the use of biocontrol agents, there is need to review the existing regulations to include clear guidelines on importation, manufacture, registration, distribution, use and exportation of biocontrol agents.

Discussion

Question
Why can't Kenya borrow a leaf from the regulation procedures in force in the neighbouring countries, i.e. Uganda and Tanzania?

Answer
Unfortunately Kenya is way ahead of Uganda and Tanzania and in fact they need to learn from Kenya.

Question
Why haven't the Dudutech products been commercialized/allowed by PCPB?

Answer
The products were discussed by the Kenya Standing Technical Committee (KSTCIE) and further referred to PCPB. PCPB evaluated the technical information and asked for biological efficacy data. It was submitted recently and it will be discussed by PCPB in May.

Question
What specific requirements are needed for importation as opposed to registration?

Answer
Specifically, importation is handled by KEPHIS, and registration by PCPB. Registration requires a lot more information than importation. Registration here is for commercial production.

Question
Can evaluation criteria used by KSTCIE for importing biocontrol agents suitable for applying at the registration and regulation?

Answer
These criteria are for research use – not commercial use. Therefore sellable products must be registered.

Overview of Registration of Pesticides in Kenya

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Abstract

The registration of pesticides in Kenya is governed by the Pest Control Products Act, Cap 346, Laws of Kenya. Since the law was enacted in 1982 many conventional chemical pesticides and biopesticides have been registered for use in Kenya. In the year 2002, a total of 2,747,368 kg of insectides worth over KSh 2 billion was imported into the country, while 2,138,642 kg of fungicides were imported. Herbicide quantities imported were the lowest, totaling 1,063,577 kg. Currently over 620 pest control products are registered of which about 30 are derived from natural materials such as plants and microbes. Over the last decade, applications for registration of biopesticides have increased. Horticultural growers have started introducing the use of botanical pesticides and natural enemies in their pest control programmes. This has been prompted by the maximum residue limits (MRLs) concerns in the European market. Most biopesticides currently being used in Kenya are based on pyrethrum and neem, but of late some based on insect growth regulators have been introduced. This paper gives an overview of the status of registration of pesticides in Kenya with emphasis on biopesticides and other closely related products.

Introduction

Regulation of pesticide use and distribution is achieved through registration, legislation and enforcement of laws governing pesticides. The Pest Control Products Board (PCPB) is the sole regulatory body that has been mandated to register all pest control products in Kenya. This is a statutory body that was created through an Act of Parliament, the Pest Control Products Act, Cap 346, Laws of Kenya, which was enacted in 1982 (PCPB, 1985). PCPB is mandated to regulate the importation, exportation, manufacture, distribution and use of products used for the control of pests.

The Act defines a pest as any injurious, noxious or troublesome insect, fungus, bacterial organism, virus, weed, rodent or other plant or animal pest; and includes any injurious, noxious or troublesome organic function of a plant or animal.

It also defines a 'Pest Control Product' as a product, device, organism, substance or thing that is manufactured, represented, sold or used as a means for directly or indirectly controlling, preventing, destroying, attracting or repelling any pest and includes:

- any compound or substance that enhances or modifies the physical or chemical characteristics of a pest control products to which it is added
- any active ingredient used for the manufacture of pest control products.

Several categories of products are included in this definition viz: conventional synthetic chemicals, microbial pesticides, botanical pesticides, biochemical pesticides, natural enemies, and plant-incorporated protectants (PIPs).

Categories of Biopesticides – Literature Review

The US Environmental Protection Agency (EPA) defines biopesticides as pesticides derived from such natural materials as animals, plants, micro-organisms and certain minerals (US EPA, 2002). Biopesticides can be categorized into five major classes.

Microbial Pesticides
Microbial pesticides consist of micro-organisms, e.g. bacteria, fungi, viruses and protozoa, or genetically modified micro-organisms, as the active ingredient agent. In Kenya, microbial pesticides based on *Bacillus thuringiensis* have been introduced e.g. Thuricide.

Biochemical Pesticides
Biochemical pesticides are naturally occurring substances that control pests by non-toxic mechanisms. Conventional pesticides are generally synthetic materials that kill directly or inactivate the pests. Biochemical pesticides include substances like semiochemicals, e.g. insect sex pheromones, enzymes (proteins), hormones, natural plant regulators, or insect growth regulators and plant extracts that attract insects to traps or repel pests.

According to the FAO Guidelines on Registration of Biological Pest Control Agents (FAO, 1988), a biochemical pest control agent has to meet the following criteria in order to be classified as such:

i) A biochemical pesticide must be naturally occurring or if the chemical is synthesized, it must be structurally identical to a naturally occurring chemical.
ii) The chemical must exhibit a mode of action other than direct toxicity in the target pest, e.g. attraction, growth regulation, mating disruption. This criterion disqualifies pyrethrum and nicotine-based products since they exhibit direct toxicity.

The FAO guidelines further state that where a chemical posseses many properties of a biological pest control agent, but does not technically meet the above two criteria, the regulatory agency should evaluate such chemicals on a case-by-case basis to determine whether it should be treated as a biochemical or conventional pesticide.

Botanical Pesticides
Botanical pesticides are also known as plant extracts. They are derived from plants, algae etc. It is difficult to put a clear boundary between botanical pesticides and biochemicals due to overlap of characterizing criteria. Neem-based products have been developed, tested and registered for various uses in Kenya.

Natural Enemies
Natural enemies are biological control agents that exist in nature. They are mainly parasitoids, predators or pathogens of pests. For the last ten years a number of natural predators have been released for the control of various pests. However, no commercial preparations have been legally allowed for sale. There is a pronounced interest to produce in mass and introduce various formulations of biological control agents in the

Kenyan market. With the development and legislation of guidelines for registration of biopesticides, such products could be made available to Kenyan farmers in the near future.

The Kenya Standing Technical Committee for Imports and Exports (KSTCIE) must clear all products based on exotic live organisms, before authority to commercialize is sought from PCPB. In some countries, e.g. USA and UK, natural enemies are exempted from registration requirements. According to the USA Code of Federal regulations Section 152.20, exemption applies only if they are regulated by another agency. If no other agency is regulating a biocontrol agent then the US EPA is mandated under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) to regulate the product. It is therefore important to consider whether it is necessary to regulate natural enemies and, if not, whether there is any other regulatory agency empowered to do so.

As indicated in the definition of a Pest Control Product, biopesticides, repellants, and attractants are included. The word 'organism' may include micro-organisms and macro-organisms. According to the Oxford English dictionary an organism may be defined as 'a living thing, especially a very small one, with parts that work together'. This could be an individual plant or animal. Based on this definition, natural enemies are indeed organisms, and the latter are not exempted from regulation under the Pest Control Products. Exempted products have to meet certain conditions as set out in the First Schedule of the Act. The FAO Guidelines on Registration of Biological Control Agents are silent on natural enemies such as predators and parasitoids (FAO, 1988).

Plant-Incorporated Protectants

Plant-incorporated protectants (PIPs) are pesticidal substances that plants produce from genetic material that has been added to the plant. For example, the gene for the *Bacillus thuringiensis (Bt)* pesticidal protein may be introduced into the plant's own genetic material. The plant, instead of the *Bt* bacterium, manufactures the substance that destroys the pest. In the United States, the protein and its genetic material, are regulated by the EPA but not the plant. In Kenya, PIPs have been introduced in crops like cotton. To date, Kenya has no regulatory guidelines on this group of biopesticides.

Process of Registration

For all pest control products, the Board considers various aspects in order to ensure safety to the public, animals and the environment. The Board considers safety, efficacy, quality and economic value of pest control products in line with the Pest Control Products Registration Regulations LN 46/1984. The Board also ensures that the technical information is summarized on the label in conformity with the Pest Control Products, Labeling, Advertising and Packaging Regulations.

Every person desiring to register a pest control product is requested to submit an application for introduction of a new pest control product, an experimental label and a copy of a dossier of technical information. If the board is satisfied with the information provided, the product is released under experimental permit for local biological efficacy trial. This is carried out in institutions that have been accredited by the Board.

On completion of the biological efficacy trial, a confidential report is received by the PCPB and the applicant applies for registration. The applicant is also required to provide a commercial label reflecting the application rates, timing of application as

recommended by the local researcher, among other things. If the Board is satisfied with the safety, efficacy, quality and economic value of a product, it is registered for a period of three years and a certificate of registration issued. This is renewable after every two years.

Under certain circumstances, a product may be granted temporary registration for a period not exceeding one year within which any missing technical or scientific information should be provided. Also, in case there is need for an emergency control of infestations that are detrimental to public health, domestic animals, crops or natural resources, a product can be granted temporary registration for a period not exceeding one year.

PCPB is empowered to suspend or revoke a certificate of registration if the content of the support documents or the application leading to the issuance was subsequently found to be false, or new information indicates that the product is unsafe, or the premises in which the product is manufactured, formulated or stored are unsuitable for the purpose.

Current Status of Registration of Biopesticides

Since the PCPB was established in 1984, it has registered a wide range of pest control products. Currently, over 620 pest control products are registered, where 295 products are under full registration, 216 are under temporary registration and 114 are under provisional registration. Out of these, about 30 products are derived from plants, or microbes. Table 1 shows a list of biopesticides and closely related products, and their recommended uses. Most of the products are based on pyrethrum extracts, and *Bt.*

Table 1: Biopesticides and related products registered for use in Kenya

Product name	Contents (a.i.)	Use
Super doom insect killer aerosol	4 active ingredients – one is 0.19% pyrethrins	For control of crawling and flying insects – cockroaches, ants, fleas, mosquitoes
Refined pyrethrum pale extract 50% w/w liquid	Pyrethrins 50% w/w	Raw material for formulating other products for use on insects (public health, veterinary, horticultural crops, in stored grains etc.)
Refined pyrethrum pale extract 25% w/w	Pyrethrins 25% w/w	–as above–
Super fine pyrethrum powder 1.3%w/w	Pyrethrins 1.3% w/w	–as above–
Crude oleo resin 25% liquid	Pyrethrins 25% w/w	–as above–
Dudukrin pet shampoo	2 active ingredients – one is pyrethrins 0.5%w/w	For control of fleas, ticks and lice in dogs and cats
Neemros 0.5% powder	Azadiractin 0.5%w/w	Insecticide based on neem seed kernal cake for use in horticultural crops
Neemroc 0.03% EC	Azadiractin 0.03%w/w	Insecticide based on neem oil for use in horticultural and agricultural crops
Baygon mosquito coil	Pyrethrins 0.035%w/w	For mosquito control

Product name	Contents (a.i.)	Use
GC-mite	Based on garlic	For control of mites
GC-3	–as above–	For control of powdery mildew
GC-3	–as above–	For control of powdery mildew
Pyerin	Based on pyrethrum	For control of a wide range of insect pests and mites
Achook 0.15%EC	Azadiractin 0.15%	Broad spectrum nematicide/insecticide
Raid mosquito coil	Pyrethrins 0.2%	For control of mosquitoes and other flying insects
Mwananchi mosquito coil	–as above–	For control of mosquitoes and other flying insects
Raid Maua mosquito coil	–as above–	For control of mosquitoes and other flying insects
Xentari WDG	*Bacillus thuringiensis* Var. *izawai* 15,000 IU/mg	Biological insecticide for the control of larval stages of lepidopteran insects on horticultural crops, flowers
Florbac	–as above–	–as above–
Thuricide HP wettable powder	*Bacillus thuringiensis* Berliner, var *krstaki* 16,000 IU/mg of formulated product	Biological insecticide for the control of lepidopteran larvae and other pests on vegetables; for the control of giant looper, green looper, leaf skeletonisers and jelly grub in coffee
Dynamec 1.8 EC	Abamectin 18g/l	Insecticide/miticide for the control of mites, leaf miners on ornamentals/flowers
Dipel 2X WP	*Bacillus thuringiensis* Var *krstaki* 32,000 IU/mg	For control of lepidopteran larvae (giant looper on coffee) and other crops
Ditera	Assorted micro-organisms	For control of nematodes on ornamentals
Aries plantomycine free flowing water soluble powder	Streptomycin sulphate 9% + tetracycline hydroxide 1%	A pesticide for use against bacterial leaf spot in carnations. Own use by M/S Sulmac
Polar 50% water soluble granules	Polyoxin AL (complex 50%w/w)	Systemic microbial fungicide for use against powdery mildew and botrytis in roses
Milfan 10WP	Polyoxin	–as above–
Flower DS	4% pyrethrins	Insecticide for the control of aphids and whiteflies on vegetables
Tracer	Spinosad	Biological insecticide for use on vegetables
Nova stalk borer	4% pyrethrins	Insecticide for the control maize stalk borer
Pyagro 4EC	4% pyrethrins	Insecticide for the control of thrips, aphids and whiteflies on french beans and roses; and whiteflies on hypericum
Blitz pet shampoo	2% Pyrethrins 10% Piperonyl butoxide	For control of ticks and fleas on dogs
Neemark	0.03% Azadirachtin	For control of aphids, thrips, and nematodes in French beans.

Over the last decade, there has been an increase in the number of applications for registration of biopesticides and related products. Through our routine visits, we have also noted an increase in the use of plant-based products, natural enemies, insect growth regulators and an assortment of microbes, mainly in the horticultural industry. This has been prompted by the maximum residue limits (MRLs) concern both locally and in the European market. Producers and exporters of fresh produce also feel threatened by the standards set on residues. There is a concerted effort between the researchers, growers and potential pesticide manufacturers to have a wide range of biopesticides developed, tested and made available for use as an alternative or complimentary to conventional pesticides.

Due to lack of specific guidelines for registration of biopesticides, each product was evaluated on a case-by-case basis. While evaluating the biopesticides, the PCPB recognized that using the traditional data requirements of conventional pesticides was inappropriate. The Board took into account the following reported properties:

- biopesticides have a narrow range of target organisms
- they have a slow mode of action
- they may require special conditions during application
- they may not be compatible with other conventional pesticides.

Quantities of Pesticides used in Kenya

Most pesticides used locally are imported from overseas. It is difficult to estimate quantities used in each sector but, generally, most insecticides and fungicides are used in horticulture.

Table 2 shows that there was an increase in the quantities and values of all groups of pest control products imported between 1994 and 1996. The period between 1996 and 2000 was characterized by fluctuations in imported quantities. In 1998 herbicides and fungicides were imported in remarkably higher quantities than in any other year. This can be attributed to the El-niňo rains of 1997, which might have led to an increase in the area under cultivation. Semi-arid areas became very productive, especially necessitating the use of pesticides. The weather conditions favoured the growth of weeds and fungi, with subsequent increase in demand for pesticides.

In the years 2001 and 2002, pesticides worth over KSh 7 billion were imported into the country. Despite the fluctuations in imported quantities, and value, there was a general increase over the reported period, showing a progressive trend in the demand for pesticides.

Table 2: Various groups of pest control products imported into Kenya between 1994 and 2002 (a) quantity (in tonnes) and (b) value (in million KSh)

Year	Insecticides and acaricides	Herbicides	Fungicides	Others*	Total
Quantity (tonnes)					
2002	2747.4	1063.6	2138.6	434.0	6383.6
2001	2318.0	1398.0	1779.0	713.0	6208.0
2000	1762.0	633.4	1665.9	370.6	4431.9
1999	2186.0	593.0	2284.0	1116.0	6179.0
1998	1814.4	1407.8	4225.4	158.8	7606.4
1997	2077.8	703.1	2391.0	655.6	5827.5
1996	1876.2	997.9	3469.8	602.5	6946.4
1995	1413.3	870.6	2323.0	501.9	5108.8
1994	1049.9	747.4	1671.8	563.3	4032.4
Value (million KSh)§					
2002	2030.4	499.4	1012.4	109.9	3652.1
2001	2122.6	324.5	957.0	154.0	3558.1
2000	1114.1	298.6	713.9	74.7	2201.3
1999	1178.0	259.0	891.0	181.0	2509.0
1998	1196.9	521.3	1358.5	37.7	3114.4
1997	1164.0	301.5	827.2	113.0	2405.7
1996	1405.4	389.9	1049.1	102.1	2946.5
1995	707.0	312.1	682.6	74.4	1776.1
1994	479.3	286.5	432.8	84.5	1283.1

* These include fumigants, rodenticides, growth regulators, defoliators, proteins, surfactants, wetting agents.
§ All figures indicate cost of product and cost of freight
Note: The data are based on applications for importation of pest control products for commercial purposes approved by the Pest Control Products Board. This excludes quantities imported by the Ministry of Agriculture as commodity aid/grants.

Conclusions

Biopesticides are said to be relatively less harmful than conventional pesticides, as they are known to be more specific to the target pest, and they degrade rapidly in the field. They are compatible with the Integrated Pest Management (IPM) programmes.

In the last decade manufacturers and growers have shown interest in the use of biopesticides. Unfortunately, production, availability and flow of these products into the country have been constrained by a number of factors, including lack of specific national registration guidelines and lack of mass production protocols. Also, registration and use of biopesticides is relatively new and intricate, and requires wide expertise; and biopesiticides are expensive to produce, maintain and store, and have a narrow range of target pests.

It is important to ensure that farmers buy products of high quality, with unquestionable efficacy, safety and economic value. Before commercialization, risk assessments are necessary in relation to human and animal health, environment, and non-target organisms.

The US EPA (US EPA, 2000) and the South African regulatory body (Rijssen, 2000) use a tiered approach to assess risks related to human, animal and environment, and such a system could be adopted in the Kenyan regulatory system. Regulatory agencies should take special consideration on toxicity, infectivity and pathogenicity of all products based on living organisms. It is also important to follow prescribed FAO guidelines (FAO, 1988) and endeavour to achieve international standards.

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Guidelines for Registration of Biopesticides

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Abstract

Biopesticides have acquired increasing importance in view of their high target specific efficacies, lack of potential for development of resistance, favourable residue profile, environmental safety and usefulness in IPM strategies. The industry is going though a period of great change with respect to registration of pesticides and though interest in biopesticides is increasing, the fact that biopesticides are naturally occurring is not a reason to blindly assume that they are safe. The statutory powers to control pesticides are contained within the Pest Control Products Act, Cap 346 of 1982 that established the Pest Control Products Board in 1985. The main aims of the Act are to protect the health of humans, creatures and plants; safeguard the environment; secure safe, efficient and humane methods of controlling pests; and to create public awareness. The PCP Act sets out the mechanism whereby these aims are to be achieved and registration is required before any pesticide is imported, sold, stored, distributed, advertised, packaged or used. This equally applies to biopesticides and they too must comply with the overall aims of the Act. However, the present data requirements were formulated with conventional/synthetic chemicals in mind and are not necessarily relevant to biopesticides and hence the need to have appropriate requirements. Clearly, both synthetic/conventional pesticides and biopesticides have much in common and will not only influence each other but will need to be cross-compliant. In August 2001 a small committee came up with a draft proposal for the registration of biopesticides. For consistency and the aforementioned cross-compliancy, they attempted to adapt the format used to register synthetic/convention and make it applicable to biopesticides. It later became evident that it was necessary to refine whatever work that was initiated by this committee. This paper gives a general overview of the proposed registration guidelines of biopesticides.

Introduction

The main purpose of environmental and ecotoxicological studies is to provide data which will determine the need for precautionary statements and limitations to minimize the potential adverse effects on non-target organisms. However, the present data requirements were formulated with conventional/synthetic chemicals in mind and are not necessarily relevant to biopesticides and hence the need to have appropriate requirements. Clearly, both synthetic/conventional pesticides and biopesticides have much in common and will not only influence each other but will need to be cross-compliant. In August 2001 a small committee came up with a draft proposal for the registration of biopesticides. It later became evident that it was necessary to refine the work this committee initiated. It is hoped that this workshop may do just that.

Ecotoxicological and Environmental Studies

Ecotoxicological Studies
Toxicological studies with technical grade active ingredient and formulated product are very important. They include acute (short term) and chronic (long term) toxicity characteristics of the active ingredient and its breakdown products.

Any chemical substance may evoke one or both of two toxic effects. The first, which is the acute effect, is the one more readily comprehensive to the layman, and normally occurs shortly after contact with a single dose of poison. The magnitude of the effect depends on the innate toxicity of the substance and upon its method of application to a particular organism. Acute toxicity very often results from the disruption of an identifiable biochemical or physiological system and, in consequence, acute toxic responses are usually readily quantifiable. A chronic effect, on the other hand, sometimes occurs when an organism is exposed to repeated small and non-lethal doses of a potentially harmful substance. Well-known chronic responses to various irritants include silicosis, lung cancer, brain damage and necrosis of the liver and kidney.

Short-term studies assess risks related to the liver, handling and misuse. Long-term investigations assess the risk of cancer or genetic effect. Reproduction studies examine any risk of embryo or foetal malformations and adverse effects on reproduction. Metabolism studies assess what happens to the product once it has entered into the body, how it moves, whether it is absorbed into tissues and how it is degraded and excreted. Based on these data, an acceptable daily intake (ADI) value can be set. This health-based value is an estimate of the human body intake of the product over a lifetime which would have no effect; it incorporates a large safety factor.

Environmental Studies
The potential effects of pesticides on the environment are of great importance. The risks to the environment from a pesticide are dependant on many factors – its toxic properties, solubility and persistence in the environment, volatility, the amount applied, type of formulation, method and timing of application, and extent of use. A wide range of environmental studies to assess the fate and behaviour of a product in soil, water and air is required. These studies provide information on the speed the product will break down and the way it is transported through the environment.

Degradation and mobility studies are very important sources of information on the fate of a pesticide in the environment. These studies usually include analytical procedures for estimating residue levels (in soil, water etc.), degradation rates, and identity of major metabolites leaching through soil.

Any potential effects on birds, aquatic organisms/species and other non-target beneficial organisms such as bees, earthworms and soil micro-organisms are also assessed.

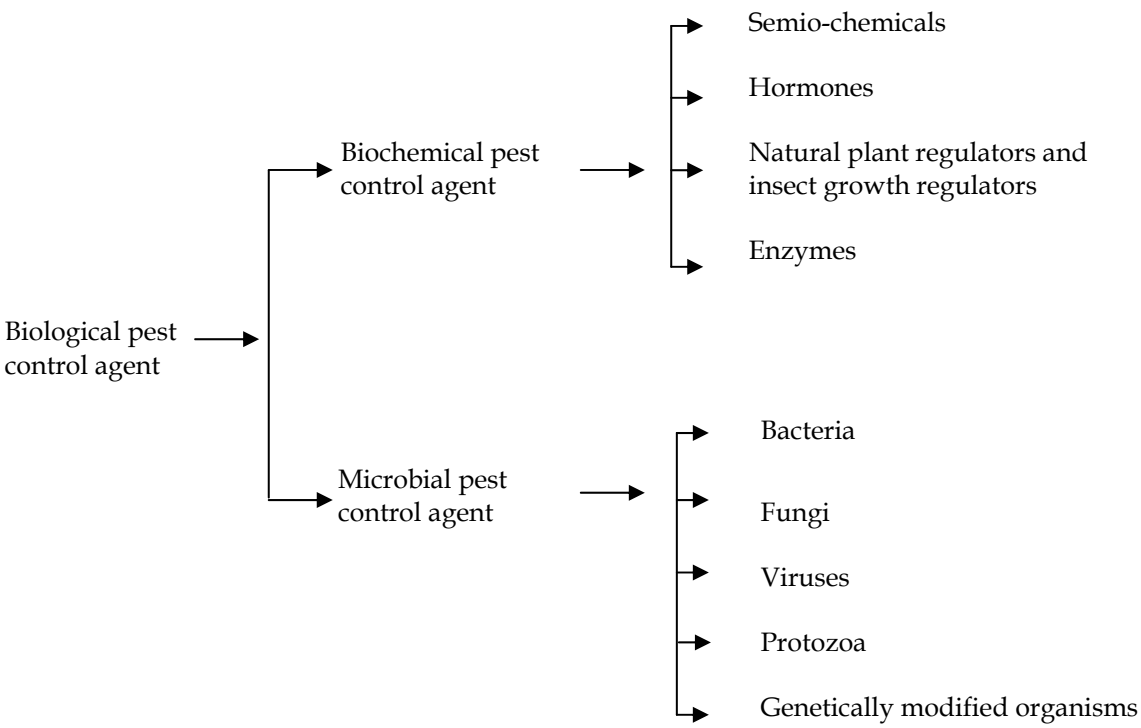
Biological Pest Control Agents

Biological pest control agents are naturally occurring or genetically modified agents that include bacteria, protozoa, fungi, viruses or their mutants for the control of invertebrate pests, weeds or microbial pathogens of crops. They could also be derived from natural materials such as animals, plants, bacteria, fungi or algae.

Caution

- A no-risk situation does not exist even for biopesticides (H.D. Burges, 1982)
- Because biopesticides are naturally occurring, it is wrong to assume blindly that they are safe. So risk analysis is important (T.E. Tolby, 1997).

Categorization by FAO



Advantages of Biopesticides

Advantages of biopesticides include:

- Usually inherently less harmful compared to conventional pesticides
- Narrow host range (environmentally advantageous, i.e. specific, so does not harm non-target organisms)
- Often decompose quickly so less potential for persistence
- Often effective in small quantities
- Less cumbersome registration regulations
- Potential for the development of resistance is less compared to conventional pesticides
- Useful in IPM strategies.

Disadvantages of Biopesticides

Biopesticides have several inherent disadvantages:

- Slow
- Expensive
- Inconsistent efficacy
- Narrow host range

- Uncertain storage/shelf life
- Incompatibility when mixed with synthetic/conventional chemicals
- Poor grower education/awareness
- Extracts from nature may have uncertain compositions.

Guidelines on Data Requirements for Biopesticides

Identity
It is necessary to establish the identity and biological purity of the agent by providing information on the taxonomy and its physico-chemical properties.

a) Active agent
   - Chemical or systemic name and strain
   - Physical-chemical properties
   - Analytical methods
   - Formulation of unintentional ingredients/impurities
   - Manufacturing process.

b) Finished product
   - Type, composition of formulation
   - Identity and purpose of inerts
   - Nature and quantity of diluent (US Environmental Protection Agency requires toxicological data for inert substances in biological pesticides)
   - Physical-chemical properties
   - Stability studies and effects of temperature
   - Formulation process
   - Analytical methods.

Biological Properties of the Active Agent
It is important to know which species are attacked by the active agent and the degree of specificity for the target pest(s) under natural conditions in addition to geographical distribution. Information on the likely biological effects arising from use is required in order to assess possible long-term changes in ecology of the crop and in the environment in general, for example:

- Mode of action
- Degree of specificity
- Application rate
- Manner, rate and frequency of application
- Relationship of agent to crop pathogen or to a pathogen of vertebrate.

Toxicology
It must be shown at any time of a proven test that the agent is not pathogenic to man and other mammals, and that the preparation does not contain any organisms or indicators of pathogenicity (faeces with coliform bacteria or mutants). It should not show any allergenicity, hypersentivity or deleterious effects.

a) Active agent
   - Acute oral
   - Acute dermal
   - Inhalation

- Acute genotoxicity
- Immunotoxicity where applicable
- Teratogenicity
- Carcinogenicity
- 90-day feeding, dermal and inhalation studies.

b) Finished product
- Acute oral
- Acute dermal
- Acute inhalation
- Eye irritation
- Skin irritation
- Skin sensitization.

Health and Professional Safety
Information is required for the purpose of assessing possible effects on health of workers handling the agent, with particular attention to allergic responses (proteins in particular are potentially allergenic).

Residues
- Chemical identity
- Nature of residues (in plants/livestock)
- Likelihood of multiplication in or on crops or food, and its effect on food quality
- Extent of indirect contamination of adjacent non-target crops, soil and water
- Analytical methods
- Proposed exceed levels from the naturally occurring biochemical agent).

Environmental and Wildlife Hazards

Information should be provided on already known biological 'side effects' on the environment from the use of, or natural occurrence of, the biological agent. Infectivity of the agent to non-pest invertebrates closely related to the pest species should be studied. Some considerations are:

- Acute oral toxicity to birds (hen, quail)
- Toxicity to fish (2 species, 1 indigenous)
- Non-target plant studies
- Non-target insect studies (honey bees)
- Degradation in water
- Absorption and binding to organic matter in water
- Degradation in soil
- Effects on soil organisms (earthworms)
- Other non-target organisms believed to be at risk, e.g. predators and parasites of target species
- Effect on livestock.

Pan-African Workshop on Biopesticide Registration

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Abstract

Harmonized guidelines from the eastern Africa working group at the 'Pan-African Workshop on Biopesticide Registration' held in West Africa, from 29 January–2 February 2001 at the International Institute of Tropical Agriculture (IITA) in Cotonou, Benin, are presented here in full, following a short report of the meeting. This document was further developed later in 2001 at a Pest Control Products Board (PCPB) meeting in Kenya, and that document forms the basis of the current 2003 meeting at Lake Nakuru.

Introduction

A 'Pan-African Workshop on Biopesticide Registration' was held in West Africa, from 29 January–2 February 2001 at the International Institute of Tropical Agriculture (IITA) in Cotonou, Benin. The workshop was sponsored by Virginia Polytechnic Institute and State University (Virginia Tech) and IITA. The event was part of Virginia Tech's United States Agency for International Development (USAID)-funded project to develop biopesticides for locust and grasshopper control in sub-Saharan African using indigenous insects, and part of IITA's Department for International Development (DFID)-funded project to develop viral biopesticides of vegetable pests in West Africa. USAID support came from the Africa Emergency Locust and Grasshopper Assistance (AELGA) project in the African Bureau of USAID.

The workshop was attended by 40 representatives of plant protection services, pesticide registration authorities, and other stakeholder organizations from 15 countries across Africa including Kenya, Uganda and Tanzania. FAO, Rome, the FAO Emergency Prevention Service (EMPRES), the Inter-African Phytosanitary Council of the Organization for African Unity (OAU), and the pesticide Action Network were represented. An expert on biopesticide registration from the US Environmental Protection Agency also participated.

The group spent five days reviewing how different microbial biological control products work, understanding how they are currently used in Africa and other parts of the world, and examining the current national and regional regulatory frameworks for registering biopesticides in Africa. Of particular interest to participants was the contribution from the South Africa representative who explained the procedures by which Green Muscle™ was registered in South Africa. The participants developed recommendations regarding how existing regulations and guidelines for the registration of synthetic chemical pesticide could be better adapted to the unique properties of biocontrol agents.

Following the workshop, working groups for West Africa and eastern Africa spent three days drafting relevant documents for their regions based on the

recommendations. The West African working group revised its draft biopesticide registration guidelines and initiated the design for a decision document for use by the Comité Sahelien des Pesticides (CSP, Sahelian Pesticide Committee) of the permanent Interstate Committee for Drought Control in the Sahel (CILSS).

In eastern Africa there is no regional system comparable to the CSP, although the South and East African Regional Committee on Harmonization (SEARCH) is working to harmonize data requirements for synthetic pesticides. The objectives of the eastern Africa work group was to develop a framing document that can be used by countries in eastern Africa to harmonize national guidelines and regulations on pesticide registration with respect to microbial biopesticides. The work group represented pesticide registration authorities from five countries (Eritrea, Ethiopia, Kenya, Uganda, Tanzania). During the workshop and work group sessions, the individual team members made plans for how these recommendations can be put to use to facilitate biopesticide registration, including their presentation to national regulatory bodies, SEARCH, and OAU inter-African Phytosanitary Council.

The eastern Africa working group's report produced at this meeting is presented below in full. This document was further developed later in 2001 at a Pest Control Products Board (PCPB) meeting in Kenya, and that document forms the basis of the current 2003 meeting at Lake Nakuru.

Harmonized Guidelines for Registration and Regulation of Biopesticides in Eastern Africa

Background statement

In eastern Africa, the use of synthetic pesticides has been the major method of pest control to mitigate crop losses (currently estimated at 30–40 per cent). These pesticides have been found to be hazardous to man and environment and are therefore not conducive to support sustainable agriculture. Currently, there are alternative methods for pest management which are environmentally friendly and suitable for sustainable agricultural production. Such methods include the use of biopesticides as part of the integrated pest management (IPM) strategies.

Unfortunately, the availability and the flow of biopesticides into the eastern Africa market has been constrained by various factors. These factors include the reluctance of industry to introduce products to the markets, unharmonized national registration procedures and absence of registration schemes in some countries. The slow mode of action of biopesticides and their narrow range of target pests compared to synthetic pesticide make them less attractive to consumers currently accustomed to quick knock-down and broad spectrum action of synthetic pesticides. All these factors have resulted in making biopesticides less competitive as compared to conventional pesticides that have well-established markets. In view of this background, guidelines for a regional harmonized registration and regulation system for biopesticides have to be developed to enhance the use of biopesticides in the region. Further to these constraints, the region lacks adequate institutional capacity necessary to support the development and promotion of biopesticides in the region.

Objectives

The overall objective is to achieve consensus on harmonization of biopesticides registration procedure in the eastern African region.

Specific objectives are:

- Examine areas of commonalties and differences
- Develop guidelines for harmonized registration procedures for the region
- Promote safe use of biopesticides.

Registration procedure

1. Pre-registration consultation is necessary for guidance
    - Phytosanitary and pesticide registration authorities

2. Application form (as attached) [to original paper]

3. Data requirement (dossier data should be generated by GLP [good laboratory practice] accredited laboratory)

    Toxicological studies (non-target, human etc.)
    - Tier 1 (an evaluation of the potential risk due to pathogenicity, infectivity and toxicity)
    - Tier 2 (more information where infectivity or toxicity is expected without any evidence of pathogenicity). (Insert information from the South African guidelines for toxicological evaluation of microbial pest control agents – page 10 to 12)

Environmental data

- The fate and behaviour of the product in the environment (spread, mobility, multiplication and persistence/residue in air, water and soil).

Ecotoxicological data

- The behaviour of the product in the biological environment toxicity to birds, fish, aquatic invertebrates, bees, terrestrial arthropods, algae, non-arthropod invertebrates e.g. annelid and mollusc and soil invertebrates, important parasites and predators of target species, and other non-target organisms
- Identity of non-target species and the extent of their exposure
- Determine proportions necessary to minimize environmental contamination and to protect non-target species).

Performance studies

- Efficacy data from counties having similar ecological environment.

Biological properties

- The natural occurrence and method of distribution of the active agent under different climatic conditions
- The target host species of the pest and the pathogenicity or antagonism to that pest; the infective dose level transmissibility and mode of action
- Indication of whether the agent is closely related to a crop pathogen or to a pathogen of a vertebrate species
- Types of crops or premises to be protected; and manner; rate and frequency of application.

Emergency procedures

In case of accidental exposure or poisoning:
- Symptoms of human poisoning; first aid treatment; skin contact; eye contact; inhalation; ingestion; antidote; note to physician.

In case of fire/spillage:
- Fire fighting measures
- Procedure in case of spillage.

Method of analysis, manufacturing, quality control and post-registration monitoring:

Method of analysis

- Analytic methods for determining the composition of the plant protection product
- Methods for determining residues in or on treated plants or in or on plant product (e.g. bio-test)
- Methods used to show micro-biological purity of the plant protection product and other mammalian pathogens or if need be honey bee pathogens (indication of method used to verify that the individual product batch does not contain harmful organisms)
- Techniques used to ensure a uniform product and essay methods for its standardization.

Efficacy testing under local conditions

National testing protocol should contain the following:

- Performance assessment
- Laboratory or growth chamber studies
- Adherence and distribution to seeds for seed treatment; performance assessment field studies
- Toxic pathogenic effects on the crop or host which is to be protected
- Compatibility with products in authorized tank mixes and with other products that are applied under expected conditions of use, recommended interval between application of microbial plant protection products and chemical pesticide to avoid loss of efficacy
- Contribution to risk reduction and integrated pest management strategies, of the targeted crop or resource.

Test product sample:

- To be supplied as per the request of the registration authorities

Fees

- May be required.

The Label

The label should be legible and easy to comprehend by the user and should contain the following basic information:

- Name and address of manufacturer
- Common name of the biopesticide active ingredient
- Systematic name of the biopesticide active ingredient
- Trade name of the formulated product
- Type of formulation
- User directions (application rate and safety period)
- Target pest(s) and crop
- Date of manufacture
- Expiry date
- First aid procedure in case of poisoning
- Handling (transport, storage and fire fighting) and disposal conditions
- Quantity of the packaging
- Registration number
- Warning and use restrictions.

Importation and Exportation

Importation

- In accordance to the FAO International Standards for Phytosanitary Measures: Part 1 – Code of Conduct for the Import and Release of Exotic Biocontrol Agents of 1996.

Exportation

- In accordance to FAO's International Plant Protection Convention (IPPC) – International Standards for Phytosanitary measures Part 1 – Import Regulations Pest Risk Analysis of 1996.

Discussion

Question

Where are the proceedings of the (Benin) Cotonou workshop? Can we expect them sometime in the near future?

Answer

Regrettably, proceedings of the Pan-African Workshop have still not been published although we have had many requests. I continue to hope that Virginia Tech (Virginia Polytechnic Institute and State University), who organized the meeting will understand the importance of publishing this document, even at this late stage.

Registration in Rest of World

Development and Registration of Biopesticides in Asia

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Abstract

India and Thailand are two countries where recently there have been successful initiatives to promote biopesticides based upon indigenous micro-organism. The registration of biopesticides poses a particular challenge and inappropriate regulation can seriously impede the adoption of biopesticides denying farmers access to a potentially valuable natural resource. India and Thailand have allowed candidate commercial products to be developed to an advanced stage where their technical viability can be judged before any registration procedure is involved. In judging the safety of nucleoplyhedroviruses (NPVs), both countries have followed the scientific consensus that these agents are not toxic and, while a formal safety approval procedure must be completed, a fast track system should be implemented along the lines of the US Environmental Protection Agency (EPA) allowing minimal toxicity testing, provision of waivers and the use of published generic data. This flexible and enabling regulatory environment has been important in bringing the benefits of new biological technology to farmers.

Introduction

In India and Thailand there has been significant progress in promoting the local production, use and registration of biopesticides. In both countries indigenous micro-organisms (fungi, bacteria, viruses, nematodes) and natural enemies (parasites and predators) have been successfully developed into plant protection tools for local farmers. Local research institutes, extension services, companies and NGOs have played active roles in developing and promoting new, safe crop protection technologies. A flexible and enabling regulatory environment in both countries has been a contributory factor in facilitating these developments.

Biopesticides are interesting as integrated pest management (IPM) agents in that they are often applied as augmentative agents. They are a natural part of the crop ecosystem but artificial propagation and application are required if they are to perform effectively as crop protection agents. In this they are strikingly different from most chemical pesticides, which are novel toxic agents whose presence in the ecosystem is alien and which therefore require careful scrutiny to ensure their use is not attended by untoward or unacceptable environmental or health consequences.

Chemical pesticides act through chemical poisoning of the target insect, and although newer insecticides tend to be more specific, insecticides are generally broad spectrum in their toxicity to insects, often affecting a wide variety of insects, often including important natural enemies such as arthropod predators and parasitoids. Biopesticides are mainly pathogens that kill hosts by infection and are mostly highly specific to pest species.

Biopesticide Registration

The registration process for biopesticides should take into account the special biological properties of these natural control agents. Registration for biopesticides presently includes within its scope wild type microbial pesticides (bacteria, viruses, fungi and protozoa). It may in due course include genetically modified (GM) microbial products, as these become available. These GM products may be considered as novel ecological entities so that with any GM entomopathogen a more precautionary approach would be justified than with non-GM microbes. Botanical pesticides are sometimes registered as biopesticides, though as these are chemical in nature they are perhaps more appropriate for standard chemical models of registration, with due account given to their often long history of prior use in agriculture. However, registration usually excludes endemic beneficial arthropods predators, parasitoids and nematodes.

The registration of biopesticides often poses a particular challenge to regulatory authorities, as their evaluation requires different expertise from that for the chemical insecticides. Registration authorities are typically staffed by scientists whose primary expertise is in chemistry and chemical toxicology. In dealing with issues associated with biopesticides, some expertise in microbial ecology, bacteriology, virology and protozoology is needed in order to understand the biology of the particular agents and evaluate key issues of safety and environmental impact. In dealing with these new agents it is often advisable for registration authorities to co-opt scientists with established expertise in these new areas in order to facilitate registration.

For the registration of chemical pesticides a fairly standard package of efficacy and safety data has been identified to evaluate a new product's value and safety. A full registration data dossier is a substantial document often requiring extensive and expensive toxicology, ecotoxicology and environmental safety data. Even a simple Tier 1 toxicity protocol requiring a minimal package of acute toxicity tests can cost a minimum of US$150,000 (EPA, 1996). For small biopesticide companies aiming to develop a range of niche products, this cost could represent a serious constraint to registering new products.

Carrying out extensive and expensive safety studies is clearly advisable when considering widespread use in the environment of a novel chemical molecule. However, their relevance to the registration of a pathogen that is a natural part of the farming ecosystem is questionable. Biopesticides such as nucleopolyhedroviruses (NPVs) are obligate pathogens of pest insects that have been shown to be non infectious to non-target insects (Laird *et al.*, 1990; Cory, 2003). They have been known for over 100 years and extensive safety testing has never disclosed any harmful effects (OECD, 2002). Further replication of safety and non-target impact studies for well understood groups of pathogens like NPV is simply not justified. Reviews of the available safety data on other biopesticides may also lead to a similar view with respect to some other groups of pathogens (Hokkanen and Hajek, 2003).

The cost of registration is a key issue. The rigid application of the chemical pesticide registration system to biopesticides is considered by many in the biopesticide industry to be a severe and unnecessary impediment to biopesticide development (Blum, 2002). This will effectively deny farmers access to a potentially valuable natural pest control resource. Biopesticides are typically developed by small to medium enterprises that

lack the financial resources of the multinational chemical companies (Jarvis, 2001). Biopesticides are often niche products with highly specific host targets, unlike most chemical pesticides where a single new molecule can be developed for controlling multiple pests. Thus, burdening biopesticides with the same registration costs as their more profitable chemical counterparts can be a severe constraint to their commercialization.

Inappropriate and unnecessarily expensive regulation will also act to impede the registration and adoption of biopesticides. Access to biopesticides is becoming an increasingly important issue in agriculture as maximum residue levels (MRLs) legislation limits or bans the use of many chemical pesticides. Biopesticides, for which there are no MRLs, will necessarily become an important tool in producing fresh produce that meets strict MRLs for produce for export to EU and OECD (Organization for Economic Cooperation and Development) countries. Therefore, the horticultural industry in countries that have a registration system that easily accommodates new biopesticides will have a clear competitive advantage over the industries in countries whose registration systems discourage product registration. This issue will not only affect food products, for example, safety fears for the handlers of flowers are also likely to lead to major limitations on pesticide residues allowed on flowers for import into the EU.

The role of regulation and registration is that of protection. A primary goal is to protect the health of humans, and the protection of domestic and wild animals and the environment. In addition, registration is aimed at protecting lawful trade and commerce by ensuring that useful commercial products are available while ensuring regulations are justified and procedures transparent. There is therefore a certain dynamic tension between the need to ensure safety and at the same time promote the adoption of new safer technologies. However this can be resolved by an appropriate and enabling approach to registration. The US-EPA has in particular taken a lead in developing fast track registration utilizing tier testing and dossier waiver to reduce the time and cost of biopesticide registration.

Early Pesticide Research in India and Thailand

In India and Thailand there was a great deal of work to develop the use and production of beneficial arthropods (mainly) predators and parasitoids (Jayanth and Manunath, 2000). Indigenous beneficials do not generally fall under pesticide registration being considered a safe and natural part of the ecosystem. However the introduction of exotic beneficials is quite correctly subject to very careful regulation for which there are well-established, internationally accepted protocols produced by the Food and Agriculture Organization (FAO) and with which Kenyan/African scientific institutions (KARI and CAB International Africa Regional Centre) are experienced.

In the last ten years biopesticides have been developed as local solutions to serious pest problems in India and Thailand. They are produced alongside a wide range of other biological controls, such as predators' parasitoids, botanicals and pheromones, to increase the IPM options for farmers (Puri *et al.*, 1997). In both countries there was a considerable history of scientific research into local baculoviruses such as NPV long before any products were developed (Jones *et al.*, 1998).

India as a Case Study

Research into the use of baculoviruses as biopesticides commenced in India as far back as the 1960s. It became a government policy priority from the mid-1980s as serious problems with chemical insecticide resistance by key pests such as *Helicoverpa armigera* in cotton became apparent. The use of non-chemical control and biological controls was seen as one solution to help overcome this insecticide resistance crisis. This has been supported strongly by the national IPM programme. Research was undertaken in national institutes (Indian Council for Agricultural Research), universities and international research institutes. It was aimed at developing endemic fungi, viruses, bacteria and nematodes as IPM/IRM (integrated resistence management) tools. All the early work was carried out under an experimental use system with NPV considered in the same way as other natural enemies. Apart from *Bacillus thuringiensis (Bt)* no importation of any exotic isolates of biopesticides was allowed. This body of research helped to develop a pool of local technical expertise that facilitated subsequent regulation.

Subsequently, from the mid-1990s, many companies took up the outputs of public sector biopesticides research and began to develop new products (Kennedy *et al.,* 1999). These products included NPVs, entomopathogenic and antagonistic fungi and entomopathogenic nematodes These companies were in many cases focussed on soft pest control technologies and often produced complementary pheromones, predators and parasitoids (Puri *et al*., 1997).

There was initially no formal registration of biopesticides but in 1999 the law was modified to specifically include biopesticides within the pesticides act. The decision to register biopesticides was perhaps partly in response to spurious products of poor quality that began to appear on the market (Kennedy *et al.,* 1999). Registration is based upon a small fee with two years to build the registration dossier (Pawar, 2001). Dossiers for NPVs were simplified for easy approval and for faster comercialization. The process of developing registration involved active discussion between manufacturers' associations, academic scientists and regulators to finalize details.

India has developed a range of biopesticide products to help its farmers meet the challenges of pest resistance to chemical insecticides. It has developed research base and skills both to develop products and to regulate them. The Indian approach allowed development of candidate biopesticides to an advanced state before registration was needed. The registration system fast tracks biopesticides and is low cost which in turn encourages local small market enterprises (SMEs) –the main biopesticide producers – to develop products and register them. Progress was aided by the existence of a well-developed local science base, strong business infrastructure and a huge potential market.

Thailand as a Case Study

In the mid-1980s Thai agriculture faced severe problems arising from insecticide resistance of key insect pests particularly bollworm (*H. armigera),* armyworm *(Spodoptera exigua)* and diamondback moth (*Plutella xylostella).* This made production of cotton, vegetables and fruit increasingly expensive and uncertain (Jones *et al*., 1993). There were also severe public health problems from pesticide poisoning related to chemical overuse and abuse (Harris, 2000).

Thailand initiated a national programme to develop biocontrol alternatives to chemicals for key pests. Active research programmes were undertaken from the late 1980s to develop local products based upon *Bt*, NPV, *Steinernema* spp. *Trichoderma* spp., *Metarhizium* spp., *Beauvaria* spp. and also predators and parasitoids. Research and development was carried out in universities and the Department of Agriculture (DoA). A very active programme to develop NPVs against *H. armigera* and *S. exigua,* using locally isolated NPVs to control these pests on cotton, vegetables and fruit crops, has been particularly successful though research was also pursued on other pests such as oil palm caterpillars (Jones *et al*., 1998). As a result of this work, in-country production of *H. armigera* NPV and *S. exigua* NPV was established by the DoA. In 1996 a new pilot plant for producing these was built by the DoA at Kasetsart University Bangkok and a pilot *Bt* plant was built in Cheng Mai.

Registration was established to cover commercial microbial products. It did not cover non-commercial production by farmers, NGOs extension services, research institutes and products distributed as part of IPM initiatives (Warburton *et al.,* 2002). The system allowed imports of some biopesticides subject to local registration (*Bt* and NPV). In-country efficacy trials supervised by DoA are required as is in-country quality testing (enumeration, bioassay, DNA, analyses for microbial contamination).

However Thailand still faces some problems in respect of biopesticides. Generating adequate, local biopesticides capacity to support local producers is difficult in a limited market. The poor quality of some of the non-commercial biopesticide production is also a cause for concern (Warburton *et al.,* 2002). Small regional biopesticides laboratories bring production into proximity with users, which may aid distribution but it can complicate quality control. In these cases the argument for a dedicated central quality control facility to monitor the production may be overwhelming (Jenkins and Grzywacz, 2000). Another problem is the illegal importation of unregistered, often ineffective biopesticide products from China and Vietnam. These products may contain extremely low levels of active agent and, sometimes, a cocktail of several agents so that their use is highly undesirable. However, where chemical pesticide resistance has reached high levels, such products are attractive to desperate farmers.

Development of in-country research expertise enabled Thailand to evolve a transparent, effective registration system that, in turn, made it attractive for producers to register products. Commercial products based on NPVs produced in America were registered in Thailand and helped to supply the farmers' needs for biopesticide. This was partly because the producers had confidence that the registration system was reliable, fair and capable of reaching a decision without unnecessary delays or the need for excessive additional expenditure on preparing dossiers.

The Way Forward

Thus a positive national policy can create an enabling environment that encourages the development of biopesticide products. It has allowed candidate commercial products to be developed to an advanced stage where their technical and commercial viability can be judged before any expensive registration procedure is involved. In judging the safety of NPVs both countries have followed the scientific consensus that these agents are not toxic or pathogenic to non-target organisms (Copping, 1998; OECD, 2002).

The need to develop a favourable regulatory environment is important if the development of new, locally produced biopesticides is not to be discouraged. Unnecessarily expensive registration procedures impede the development of biopesticides, as these are usually developed by small local companies lacking the resources of major chemical companies. Expensive registration operates to favour monopolization of the market by a few imported chemical pesticides developed by large multinational companies.

One model to promote biopesticides is a fast track registration system along the lines of that developed by the US EPA (EPA, 1996). Here the adoption of a reduced tier of simple toxicity tests, provision for the acceptance of waivers, and acceptance of published or public data have lowered the costs of registration and led to the registration of a range of new biopesticides.

A key focus for regulation is to ensure that all commercial products meet acceptable performance and quality standards. There are proposed standards for a number of such biopesticides including *Bt* (Dulmage *et al.*, 1981), fungi and viruses (Jenkins and Grzywacz, 2000). In determining appropriate protocols for field efficacy tests, we now have considerable consensus on acceptable practices for field trials – though no recommended guidelines have been published for most biopesticides (Lacey and Kaya, 2000). In developing these systems, active dialogue between producers, scientists and regulators is important in order to balance the sometimes-conflicting needs of regulation and commerce.

One problem for registration authorities can be how to judge the validity of submitted data and this becomes especially acute where the data are of a type unfamiliar to regulators whose technical expertise is in chemistry. The acceptance of public data in the form of published papers and reports as part of the registration dossier can ease this problem as data from reputable journals have, in effect, already been scrutinized by independent expert referees and have been exposed to scientific scrutiny and refutation if false.

Development of Regulation System

It is clear from these case studies in Asia that other countries can build systems of regulation that enable them to exploit the wealth of natural pathogens for agricultural development without risk to their peoples or environment.

Key factors in the development of such a system are in my opinion the acceptance of a flexible but scientifically rigorous approach to registration. The process can be speeded up and the cost lowered in a number of ways including:

- Acceptance of published data where appropriate
- Use of waivers for registration dossiers where adequate data are already available
- Adoption of fast tracking for biopesticides whose safety is generally accepted
- Adoption of tier toxicity testing
- Regional harmonization of registration procedures.

Waivering is exempting the need to do key toxicity and ecological impact tests where sufficient published or existing data already exist and is crucial to reducing the registration costs of biopesticides by reducing unnecessary testing.

Tier toxicity means instead of rigid demand for a full range of toxicity tests for biopesticides, data on a minimal batch of acute toxicity tests are mandatory (acute dermal, acute mammalian, acute inhalation). Only if a substance fails one of these are more extensive, expensive chronic and reproductive toxicity tests needed.

Regional harmonization is important as, by creating large markets, the registration of new products is encouraged. There is no doubt that in India – a country of a billion people – the huge potential market for biopesticides, all under a single regulatory process, is an attractive feature to companies developing new products.

Conclusions

There is no doubt that the vitally important fresh produce and flower industries in Kenya see a need for new biopesticides. The success of this industry is a key generator of employment and income to millions of its poorer citizens. Kenya has made a start in developing a range of such products under the DFID Crop Protection Programme (Miano *et al.,* 2000; Ogutu *et al.,* 2002). The challenge now is to put in place a registration system that will allow the rapid and efficient registration of useful effective biopesticide products while protecting farmers from ineffective ones. Only with such a system can Kenya ensure that its vital horticultural industry has access to the essential inputs it needs to continue to flourish and provide the country with a major source of income.

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Discussion

Question
On sharing benefits between researchers and subsequent development partners what are the modalities for Thailand and Indian case studies?

Answer
It is up to the researcher and companies to determine how this relationship can generate benefits for the researcher and research institutes. It can be through simple consultancy fees or through licensing agreements where the company pays the researcher an agreed percentage of the selling price of the product.

Also public bodies such as the European Union or national governments have programmes to fund researchers who work with companies to develop new products, this is becoming an increasingly important mode at public funding for science in the EU and also likely to be favoured by aid donors in future.

Registration of Biopesticides in Europe and OECD Countries

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Abstract

The paper focuses on microbials and also covers biochemicals, semio-chemicals and natural enemies. It summarizes the European registration process and addresses the parallel initiatives being co-ordinated by the Organization for Economic Cooperation and Development (OECD)[1] on behalf of its broader range of member countries. Applicants for registration must present a comprehensive and transparent supporting dossier of data and information in a prescribed format. Dossiers put the laboratory, field and published reports into context of the proposed use by providing a full risk assessment. This ensures that there will be no unacceptable risks to users, bystanders and workers in the crop; consumers, if food crops are to be treated; and all exposed environmental compartments and non-target species. It must also be shown that the product is efficacious. The detailed data requirements for microbials are listed in Directive 2001/36/EC which requires data and information on the active organism (Annex IIB) and each formulated product (Annex IIIB). Dossiers required to support the authorization of biopesticides have been smaller and less costly to generate than those for traditional chemical pesticides. However, resources will be significant to generate the data package, prepare and support the dossier and cover the authority's fee.

The Legislation – The European System

During the several years of moving towards a harmonized EU system, it has been necessary to take account of a broad range of scientific and policy perspectives in the different countries and registration of microbials can still take years. However, experience is increasing on all sides. The guidelines for risk assessment are under continued development and will take full account of the special features of 'biological' plant protection products. It is important to note that the legislation is under revision to include OECD initiatives to harmonize documentation and data requirements. The revised legislation will be agreed in 2004. This paper therefore provides a broad overview of the registration process which should be generally applicable after revision of the parent legislation.

[1] List of OECD countries is in Annex 1 at the end of the paper.

An historical account of the legislation of biopesticides under the European system is as follows:

- **1991 –** 15 different national systems were in force
- **1993 –** Directive 91/414/EEC is the main item of regulatory legislation that applies to all EU member countries governing marketing and authorization of all plant protection products. This Directive provides a list of active substances authorized for incorporation in plant protection products (Annex I) and lays down the requirements for application dossiers for new active substances (Annex II) and new plant protection products (Annex III). In both these annexes, a distinction was made between chemicals on the one hand (Part A) and micro-organisms and viruses on the other (Part B).
- **1996 –** OECD survey of biopesticide rules
- **1998 –** EU Workshop indicated a more microbiological approach was required for biologicals
- **2001 –** Since it was recognized that microbial agents act in very different ways from chemical active ingredients, different data requirements were published. The changes to Directive 91/414/EEC are listed in Directive 2001/36/EC. This Directive replaced Part B of both Annexes II and III by giving special data requirements for microbials. These include the specific identity of the micro-organism, its biological properties, effects on target and non target organisms, effects on animal and human health, life cycle, infectiveness, relationships to known human and animal pathogens, stability and ability to produce toxins. A copy of Directive 2001/36/EC is found in the Official Journal of the European Union at: http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=EN&numdoc=32001L0036&model=guicheti.
- **2003–04** Status of the parent Directive 91/414/EEC: Revised legislation to be agreed in 2004. This will include the consolidation of all guidance documents and amending Directives. It will include OECD initiatives to harmonize documentation and data requirements.

Categories of Biopesticides

Biopesticides may be divided into the following categories:

- Biochemicals
- Semiochemicals
- Micro-organisms and viruses
- Macro-organisms.

Table 1 summarizes how each of these categories is currently described and the data requirements currently needed under Directive 91/414/EEC with a summary of issues under discussion for future amendments of the Directive.

Table 1: Categories of biopesticides and data requirements for authorization and marketing under Directive 91/414/EEC and future amendments

Category of biopesticide	Description under Directive 91/414/EEC	Data requirements given in	Issues under discussion for future amendments
Biochemicals (Plant extracts, naturally occurring chemicals, plant strengtheners)	Chemical substances	Annex IIA (active substance) Annex IIIA (formulated product)	Reduced data requirements and definition of modes of action included
Semiochemicals (Chemicals which affect behaviour of insects: pheromones, allomones, kairomones)	Chemical substances	Annex IIA (active substance) Annex IIIA (formulated product)	OECD has published data requirements for a reduced data set which may be followed
Micro-organisms and viruses	Viable entities in scope of Directive 91/414/EEC	Special data requirements are published in amending Directive 2001/36/EC Annex IIB (active organism) Annex IIIB (formulated product)	'Uniform Principles' containing transparent criteria for acceptance of dossiers on plant protection products containing micro-organisms
Macro-organisms	Not regulated by 91/414/EEC	Covered by legislation on release into the environment	Follows FAO code of conduct on release of exotic isolates

Overview of the Regulatory Process

For this workshop an outline of dossier preparation and assessment under Directive 2001/36/EC is provided to highlight the stakeholders involved in the process and to emphasize the expertise required by both applicants and assessors.

1 Dossier preparation by the applicant

Regulatory submissions must be presented in a prescribed format which is laid down in Document 1663/VI/94 (22 April 1998) rev. 8. This provides applicants with a framework to present their laboratory and field data, published reports into context of the uses and facilitates the risk assessment. This dossier structure is helpful to applicants but was developed to organise the substantial and complex packages required in full chemical dossiers, so it is debatable whether so many supporting documents are justified for biological products.

2 Dossier assessment by the regulatory authorities

Completeness check

- Authority and applicant resolve unclear issues/questions arising from the dossier

- All EU Member States are consulted
- The dossier is then judged complete
- This process takes six months
- The positive decision is published in the Official Journal of the EC.

Draft Assessment Report (monograph)

- The Draft Assessment Report (DAR) is prepared by the designated 'Rapporteur Member State' (RMS) authority to current published guidance
- Document 1654/VI/94 (22 April 1998) rev. 7
- This step takes 12 months
- This is peer-reviewed by EU experts to support the listing of the active substance (a.s.) in Annex I of the Directive
- This harmonized EU decision should allow more efficient product authorizations.

Documents included in the Draft Assessment Report

- Level 1 – statement of purpose
- Level 2 – overall conclusions
- Level 3 – proposed decision
- Level 4 – further information required to support Annex I listing
- Annex A – reference list
- Annex B – summary and evaluation of data
- Annex C – confidential information.

Who considers the Draft Assessment Report?

- Regulatory authority officials in all EU Member States
- National Committees
- European Commission officials
- EU peer review groups
- EU scientific committees
- The European Food Safety Authority (EFSA)
- EU Standing Committee on the Food Chain and Animal Health (SCAH)
- Applicant
- The general public.

3 Essential qualities of good dossiers and Draft Assessment Reports

- Critical and scientifically rigorous
- Consistent and to the acceptable format
- Transparent to the reader
- Flexible to cover a broad range of active substance types
- Accessible
- Can be updated and amended
- Facilitates efficient use of resources.

4 Areas of expertise required by applicants and assessors

1. Microbiology
2. Chemistry
3. Residues
4. Toxicology

5. Human exposure – consumer and user
6. Environmental fate and behaviour
7. Ecotoxicology
8. Efficacy
9. Regulatory expertise
10. Project management.

Generally, the onus is on the applicant to address all relevant data requirements so the dossier must address every data point (waivers may be submitted where a data requirement is not appropriate to the case under consideration) and address all potential risks before it is evaluated in detail by the RMS authority. Data and risk assessments must cover the following areas: Users, Bystanders and Workers in the crop; Consumers, if food crops are to be treated; all exposed Environmental Compartments and Non-Target species; Efficacy.

The authority then prepares its own risk assessment and documentation. In this process the applicant and regulatory authority officials are required to have complementary skills and apply common principles.

Dossiers required to support the authorization of biopesticides have been smaller and less costly than for traditional chemical pesticides.

Micro-Organisms Considered Under the EU System

The Directive 91/414/EEC applies to new active substances and products containing them, which were placed on the market after 25 July 1993. Existing microbial actives (pre 1993) are shown in Table 2. Little action has been required so far for existing actives but in the near future (current estimate: mid-2005) dossiers will be required under stage 4 of the review programme.

Table 2: Existing microbial actives (pre 1993) and new actives

Bacteria	Fungi	Viruses
Existing actives		
Bacillus sphaericus	*Aschersonia aleyrodis*	*Agrotis segetum* GV
Bacillus thuringiensis	*Beauveria* spp.	*Cydia pomonella* GV
Streptomyces griseoviridis	*Metarhizium anisopliae*	*Mamestra brassica* NPV
	Phlebiopsis gigantea	*Neodiprion sertifer* NPV
	Trichoderma spp.	*Tomato mosaic virus*
	Verticillium spp.	
New actives		
Pseudomonas chlororaphis	*Paecilomyces fumosoroseus*	*Spodoptera exigua* NPV
Conithyrium minitans	*Ampelomyces quisqualis*	Mild strain zucchini yellow mosaic virus
Gliocladium catenulatum		
Bacillus subtilis		
Etc.		

In the case of new active substances (post 1993) dossiers are submitted as soon as they are completed. The first three new microbials submitted between 1994 and 1996 were considered by an EU expert panel in 1998 which reviewed procedures and made

recommendations to move the evaluation process forward. Annex I listing was achieved in January 2002 for the first microbial, *Paecilomyces fumosoroseus,* a fungal pathogen of insects, and the others are close to completion (Post meeting note: by mid-2004 there were four positive Annex I listing decisions for micro-organisms). As the Directive allows provisional authorisations to be granted by Member States, some of these products have been on the market for some years. Fortunately, registration of other new micro-organisms is progressing faster thanks to experience gained by all stakeholders, and the availability of guidance documents. This is fortunate as full dossiers will also be needed in 2005 for all existing active substances.

Annex 1 European and OECD countries

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
European Communities
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Japan
Korea
Luxembourg
Mexico
New Zealand
Netherlands
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

Discussion

Question
What is the cost of registration in EU?

Answer
The UK registration fee is Pound sterling 40,000 – but the UK intends to ask for public support to reduce costs to assist the development of biopesticides. (Post meeting note: UK now operates a pilot scheme with reduced fees, so more biopesticides are available to UK growers).

Registration of Biological Pesticides in Cuba

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Abstract

Cuba is a pioneer of low-input 'urban and periurban' agriculture, in which intensively cropped smallholdings (approximately 2 ha) are dispersed amongst the residential areas, often with an on-site farm shop selling fresh vegetables to the local community. These units use biomanagement strategies for crop protection, demanding biopesticides as key components in Integrated Crop Management. A network, throughout the country, of approximately 200 small production plants (CREE) produce several microbial control agents, including *Bacillus thuringiensis, Metarhizium anisopliae, Lecanicillium lecanii, Trichoderma harzianum* and entomopathogenic nematodes for pest and disease control by local farmers. Currently, the production of these biopesticides does not meet the demand, both in quantity and quality.

Current legislation in Cuba, in harmonization with international policies, demands that microbial pesticides are subjected to detailed studies of their environmental impact and toxicological effect before they are registered. The regulation system has to be flexible and not be too costly or too lengthy but it must have the full and justified trust of the public. As current legislation stands, there are certain categories of microbial pesticides that have an easier and quicker passage to registration than others. Indigenous micro-organisms that have never been recorded as plant, animal or human pathogens and which are specific to a defined group of targets have a comparatively straightforward progress through assessments for environmental impact and toxicological testing. The processes used in Cuba are outlined in this paper.

Introduction

In recent years, much has been written on biological pesticides, especially microbials (bacteria, algae, fungi, viruses and protozoa), which are the subject of these guidelines. There is extensive literature on risks, particularly with reference to the lack of data and studies to support current safety criteria. Nevertheless, the extensive use during the past 40 years of *Bacillus thuringiensis*, together with the toxicological and ecotoxicological studies carried out on its various subspecies and strains, have shown that the use of this organism is harmless, as long as the absence of exotoxins, which are noxious to humans, is ensured.

[*] Representing: Central Register of Pesticides and External Quarantine Department of the National Plant; Pathology Centre (CNSV), Ministry of Agriculture (MINAGRI); National Centre for Biological Safety (CNSB), Ministry of Science, Technology and the Environment (CITMA); Centre for Environmental Inspection and Control (CICA), CITMA; National Toxicological Centre (CENATOX), Ministry of Public Health (MINSAP)

During the 1990s, numerous Cuban organizations started developing microbial pesticides. For example, root-knot nematodes (*Meloidogyne* spp.) are major pest of vegetable crops worldwide and the nematophagous fungus, *Pochonia chlamydosporia* (Goddard) Zare and Gams, has been investigated as a potential biological control agent for use in integrated pest management strategies for *M. incognita* (Kofoid and White) Chitwood in vegetable crops. Indigenous isolates of the fungus have been identified in Cuba and those with most potential as biological control agents have been developed as part of a five year collaboration between CENSA (Centro Nacional de Saindad Agropecuaria, Cuba) and Rothamsted Research, funded by Rothamsted International, British Council and DFID. A single application of the fungus has reduced root-knot populations by up to 70 per cent. A small pilot plant to optimize the mass production and quality of the inoculum of the fungus has been built in CENSA and more extensive field testing is underway with support from the European Commission.

In the light of the background referred to above, and given that the national and international regulatory institutions have now developed improved requirements for the registration and control of these pesticides, the MINAGRI and CITMA have decided to publish this document. It aims to provide guidance to applicants for the registration of a biological pesticide in accordance with current Cuban legislation. Information is provided on current procedures and mechanisms, as well as on the steps required for obtaining the corresponding licences and permits.

Regulation and Control of Biological Pesticides

There are several Central Government Organizations responsible for the regulation and control of these biological products. The following legislation applies:

- Decree No 153 and 169 Plant Pathology Regulation, 1994
- Central Register of Pesticides, Joint Resolution of the Ministry of Public Health and the Ministry of Agriculture, 23 March 1987
- Resolution 435 External Quarantine, Imports, 1994
- Resolution 434 External Quarantine, Exports, 1994
- Law No 81 of the Environment, 1997
- Resolution No 111 Biological Diversity Regulation, 1996
- Resolution No 77 Environmental Assessment Regulations, 1999
- Decree No 190 on Biological Safety, 1999
- Resolution No 76 Regulations for granting Biological Safety Authorizations, 2000.

The institutions responsible for enforcing the above legislation are:

- Central Register of Pesticides, MINAGRI/MINSAP, is responsible for the study, assessment and approval of pesticides. It forbids the introduction into the country, and use of, any pesticide formulation that is not registered.
- Centre for Environmental Inspection and Control (CICA), CITMA, controls access to biological diversity and any projects or activities involving research on, and/or production of, biological pesticides.

- National Centre for Biological Safety (CNSB), CITMA, is responsible for the authorization of research, production, trials, release, import and export of these pesticides, as well as of the various steps in the construction of the laboratories where they are produced

- External Quarantine Department, National Centre of Plant Pathology (CNSV), MINAG, is responsible for the authorization, control and prohibition of the import and export of materials under quarantine (amongst them, biological pesticides).

In addition to these institutions, the National Toxicological Centre (CENATOX), where both the Advisory Toxicological Commission and the Group of Inspectors are based, is responsible for the accreditation of laboratories for toxicological trials.

There are several steps in the development of a biological pesticide, and one or more of the institutions above will be involved in each of these.

Requirements for Registration

Before an application for registration and other necessary authorizations can be made for a biological pesticide, the following requirements must be fulfilled:

- Identification and description of the variety, and characterization of its metabolites
- Description of the final formulation of the product
- Description of the manufacturing process
- The relevant documents must be enclosed, with appropriate guarantees, e.g. the formulation, certificates of quality control, etc. The guarantees must have the signature and official stamp of the manufacturers or other relevant guarantor
- Back-up to all the information provided must be enclosed (photocopies, certificates, bibliography).

Once these requirements are satisfied, the next step is to fill in the application forms of the centres mentioned above which are also listed in the Annexes (at the end of the paper).

Procedures for Registration

An application must be duly completed and submitted to the Central Register of Pesticides. A specialized group will review this, checking that the application contains all the relevant information and documents. If it is found that not all toxicological trials have been carried out, or that any other necessary studies are lacking, the Register will transfer the application to the Toxicological Advisory Commission. The latter is responsible for determining which toxicological and ecotoxicological studies must be carried out. Once this is done, the Commission will contact the applicant to provide the names of the institutions that are authorized to carry out such studies. The applicant will then choose one of these institutions to carry out the trials.

Once the trials are completed, the organization that has carried them out will send a comprehensive report, duly signed, to the Toxicological Commission. The Commission will analyse this and will decide whether any further studies are necessary. If no further studies are needed, the Commission will send the reports to the Central Register of Pesticides for the Register's Advisory Committee's final evaluation.

Apart from containing all the necessary toxicological and ecotoxicological information, the application must also include the official registration application as an annex.

Need for Further Toxicological Studies

When further toxicological studies are recommended, it is useful to remember that the national and international health authorities have recognized the need for appropriate legislation that can ensure the quality, efficacy, effectivity and non-toxicity of any new commercial products. This has resulted, among other things, in guidelines for good laboratory practice (GLP) being drawn up. These aim to improve trials in order to generate high quality data.

There may be some variations between the legislation of different countries. Nevertheless, the GLP principles apply to all studies that are carried out to assess health and environmental safety. All national legislations require that these principles be satisfied when wishing to register or obtain licences for pharmaceuticals, pesticides, cosmetic products, food additives, veterinary drugs or industrial chemical products.

Registering Biopesticides

In order to register biological pesticides in Cuba, accredited laboratories must carry out the toxicological studies, so that the validity of the results is assured. These laboratories are therefore subject to an accreditation process whereby the use of GLP is verified through inspections, with Accreditation Certificates being granted to the laboratories that adhered to such practices. This process is carried out by a group of inspectors coordinated by the National Toxicological Centre. They are responsible for carrying out the inspections mentioned, and submitting a report to the regulatory authority recommending, or not, that a Certificate of Accredited Laboratory is issued.

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Annex 1 Information for the Registration of Biological Pesticides

1 Identification and description of the organism

1.1 Common name and any alternative names

1.2 Scientific name and strain or serotypes of bacteria, protozoa and fungi; indicate whether it is a variety or a mutant strain – in the case of viruses, name of the agent, serotype, strain or mutant

1.3 Taxonomy

1.4 Reference numbers of the culture and name of the collection where it is stored

1.5 Procedures and applicable criteria for the identification of the organism (e.g. morphology, biochemistry, serology)

1.6 Composition – microbiological purity, nature, identity, properties and content of any impurities or foreign organisms.

2 Biological properties

2.1 Target pest and degree of specificity of the biopesticide. Pathogenicity towards the host, infectivity dose and transmission

2.2 Mechanism by which the host is affected

2.3 History of the organism and its utilization; natural presence and geographical distribution

2.4 Effects on other species

2.5 Infectivity and physical stability during utilization with the proposed application method; effect of temperature, exposure to environmental radiation, etc. Persistence under the environmental conditions to be expected on application

2.6 Discuss whether the organism is closely related to pathogens of cultivated plant species or of any non-target vertebrate or invertebrate animal species

2.7 Laboratory demonstration of the organism's genetic stability (i.e. mutation rate) under the environmental conditions under which use is proposed

2.8 Presence, absence or production of toxins, and their nature, identity, chemical structure (if relevant) and stability

2.9 Mechanisms to avoid the loss of virulence in the original culture.

3 Other data

3.1 Purpose of the organism, e.g. fungicide, herbicide, insecticide, repellent, growth regulator

3.2 Crops and animal species on which the use is being applied for

3.3 Planned area of application, e.g. field, glasshouse, human food or animal feed stores, hospitals, proximity to children, residential area

3.4 If relevant, and in accordance to the test results, describe the specific agricultural, plant pathology or environmental conditions under which the organism can be utilized, or under which it must not be utilized

3.5. Production method, including techniques employed in order to guarantee the uniformity of the product, and the methods employed to control its identity. If the organism is a mutant, detailed data must be provided on its production and isolation, as well as on all known differences between the mutant and the wild parental strains

3.6 Probability that the organism becomes not infectious

3.7 Methods and precautions advised for the manipulation, storage and transport of the organism, as well as in case of fire.

4 Analytical methodology

4.1 Methodology employed to determine the identity and purity of the culture from which the batches were produced, and the results obtained, including information on variability

4.2 Methodology employed to demonstrate the microbiological purity of the final product, and to achieve an acceptable level of control of contaminants. Results obtained, including information on variability

4.3 Methodology employed to demonstrate that the active agent does not contain human or mammal pathogens including, in the case of protozoa or fungi, a test on the effects of temperature (at 35°C and other relevant temperatures)

4.4 Methodology employed to determine viable and not viable residues (e.g. toxins) in the treated products, human foods, animal feeds, body fluids, human and animal tissues, soil, water and air, where applicable.

5 Formulation data

5.1 Name and type of formulation

5.2 Physical and chemical properties:

- Physical state
- Density
- pH

5.3 Suspension capacity, particle size, moisture capacity and other characteristics depending on the type of formulation

5.4 Concentration of the active agent

5.5 Nature and quantity of other components

5.6 Purity

5.7 Potency

5.8 Purpose and identity of non-active ingredients, e.g. protection against UV light, water-retention agents, etc.

5.9 Compatibility with other formulations

5.10 Container employed

5.11 Stability of the product and the effect of temperature and storage conditions on its biological activity

5.12 Analytical methods for quality control of the formulation

5.13 Precautions during storage, transportation and in case of accident

5.14 Dose, frequency and method of application

5.15 Procedures to destroy or decontaminate containers

5.16 Procedures for cleaning application equipment.

6 Toxicological data

6.1 Toxicity and/or pathogeneity and infectivity

- Acute oral toxicity and pathogenicity
- In those cases where a single dose is not sufficient to evaluate pathogenicity, provide information on assessment tests necessary to detect high toxicity agents and their infectivity
- Acute skin toxicity and pathology
- Acute respiratory toxicity and pathogenicity
- Acute parenteral (by injection) toxicity and pathogenicity
- Skin and eye irritation
- Hypersensitivity.

6.2 Sub-chronic toxicity

6.3 Other toxicological studies
- Genotoxicity
- Reproductive effects/ effects on fertility
- Metabolic studies – absorption, distribution and excretion in mammals, including a description of the metabolic paths.

6.4 Viruses, viroids

6.4.1. Toxicity and/or acute pathogenicity and infectivity.

In addition to the studies previously mentioned, describe any other studies with cell cultures which use purified infective viruses, and primary cell cultures of mammal, avian or fish cells.

7 Ecotoxicological studies

All microbial pesticides must be subject to the following basic studies:

- Acute toxicity and/or pathogenicity and infectivity on:
  - fish
  - aquatic invertebrates
  - bees
  - birds
- Effects on algal growth
- Studies on non-target plants and insects
- Acute toxicity on other non-target organisms that could be affected.

If any adverse effects are observed during these studies, further research must be carried out on environmental impact, to evaluate the population dynamics and environmental niches and organisms affected.

Annex 2 Information Required to Carry Out Research, Trials and to Export Biopesticides

In the case of **exports**, in addition to the information outlined in Annex 2, it is necessary to obtain a 'Cooperation Contract' with the institutions or countries to where the pesticides are to be exported.

For the rest of the activities, besides the information included in Annex 2 the following information must also be provided:

1 Information on the pesticide's intended use

- Risk and benefit analysis by release of the microbial pesticide
- Information regarding previous occasions when the product has been used
- Number and volume of the organisms to be released
- Description and geographical location of the release area. Experimental design. Confinement characteristics or requirements
- Biological, ecological and genetic data on the species present in the release area/site (knowledge of biodiversity)
- Scale and frequency of the releases
- Risk management measures and their verification – cost-benefit analysis must be an essential part of the risk management
- Training and supervision of personnel on biosafety matters
- Likelihood that any adverse effects occur after the organism has been released
- Measures taken during production to assure the quality and purity of the organism to be released
- Transport conditions for the organisms to be released
- Describe in detail the measures which must be taken to reduce populations or eliminate organisms once the release has been completed
- Distance between the release site and water for human consumption.

2 Controls for the release of the organism, including risk management measures depending on the organism to be released

- Procedures to avoid and minimize dissemination of the organism
- Procedures to control access of non-authorized personnel
- Procedures to prevent other organisms entering the site.

3 Control techniques to detect the organism in the environment

- Monitoring programme, including its design
- Person(s) and institution(s) responsible for monitoring
- Monitoring methodology
- Sensitivity, specificity and reproducibility of the methods employed
- Duration and frequency of monitoring (time-plan)
- Training of monitoring personnel
- Facilities where the monitoring will be carried out (specify whether these are accredited). Safety conditions in these facilities.

4 Emergency procedures

- Methods and procedures for controlling the organism in case of dissemination
- Isolation methods for the affected area
- Methods to eliminate, clean or make safe any plants, animals and the environment which might be accidentally exposed to the organism

- Human health and environmental protection plans should adverse effects occur
- Mitigation measures, decontamination and recovery.

5 Residue control

- Type of residues that will be generated
- Foreseen volume of residues
- Potential risk posed by these residues
- Procedures for residues control: disinfection, sterilization and final elimination measures; validation of the methods employed and control of their efficacy
- Residues transportation.

6 Receptor environment

- Potential risks of the released organism to humans and the environment
- Size of the local human population
- Proximity to humans, plants and fauna
- Availability of viable niches for the organism to be released
- Description of the ecosystems which could be affected by the release
- Potential capacity of organisms in the environment to receive genes from the released organism
- Known or foreseen environmental conditions which could affect the survival and multiplication of the released organism
- Competitive advantage of the released organisms in relation to the organisms already present in the ecosystem
- Likelihood of an excessive increase in the population of the released organism in the environment.

7 Other data

Specific geographic, climatic and geological characteristics of the receptor environment:

- Characterization of soils and their classification, potential use
- Profile, characteristics of the subsoil
- Filtration index: hydraulic permeability coefficient
- Topography, size and shape of particles, fertility
- Leachable toxins: pesticides, heavy metals, and other chemicals substances
- Climate (regional and local), based on a climatic series covering at least 30 years including maxima, minima, and their space-time distribution
- Wind: predominant directions, speed, seasonal variations, intensity and frequency of severe storms, tornadoes and hurricanes
- Water temperature, variations
- Characteristics of the area: slopes, vegetation cover, run-off.

Annex 3 Information that Laboratories Manufacturing Biological Pesticides Must Submit to the National Centre for Biological Safety (CNSB)*

Construction Phase

1 Letter applying for the Biological Safety Licence, with the name and signature of the Director of the applicant's facility. This must be backed by the Biological Safety Commission of the applicant organization.

2 Description of the biological agents and sample types which contain, or may contain, biological agents which are or will be employed, including:

- 2.1 Micro-organisms or pests: Identification: scientific name, common name, synonyms, taxonomy and origin
- 2.2 Toxins: Organism which produces them, infectious dose, source of contamination, transmission route and incubation period.

3 Physical description of the laboratory facilities. General description of the production process, indicating how biological safety measures are or will be implemented.

- 3.1 Maps of the buildings subject to biological risk
- 3.2 Construction information, including construction characteristics, construction system, materials, and characteristics of walls, ceilings, doors, paint, sealers, windows, floors, sanitary facilities (hand basin, showers, eye-wash, etc.), drainage, pipes (water, steam, vacuum, etc.)
- 3.3 Data on the ventilation and cooling/heating systems.

4 Treatment of hazardous biological residues.

- 4.1. Type of residues produced and treatment envisaged for each type
- 4.2. Transport of residues: type of transport, characteristics of the containers, etc.

Restructuring Phase

In addition to the data required for the construction licence, documents must be submitted providing a physical description of the laboratory facilities, the work flow, personnel flow, and flow of materials, indicating how the biological safety measures are, or will be, implemented.

1 Once the relevant licences have been obtained (Environmental Licence, Construction Licence or Restructuring Licence), the following documents must be submitted:

- a) Application letter requesting the licence to start operations, signed by the Director of the facilities or laboratory
- b) Certification of the relevant licences

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* Details of verification tests can be obtained from the author or the Director, CNS (see Annex 7)

c) Data from the verification tests carried out in order to establish that operations could start
d) Details on professional background and experience of personnel carrying out verification tests
e) Certification of the equipment employed to carry out verification tests.

2. If the licences were not requested at the beginning of the process, or not all the licences have been obtained (Environmental Licence, Construction Licence, Restructuring Licence), besides submitting the documents required for the construction licence, the following additional documents must be submitted:

a) Data from the verification tests carried out in order to establish that operations can start
b) Details on professional background and experience of personnel carrying out verification tests
c) Certification of the equipment employed to carry out verification tests.

Production Phase

1. Once the relevant licences have been obtained (Environmental Licence, Construction Licence or Restructuring Licence, and Licence to Start Operations), the following documents must be submitted:

a) Application letter requesting the Production Licence, signed by the Director of the facilities or laboratory
b) Certification of the relevant licences
c) Information on personnel training, including training programmes for different staff bands, safety manual or safety regulations, and emergency procedures.

2. If the licences were not requested at the beginning of the process, or not all the licences have been obtained (Environmental Licence, Construction Licence or Restructuring Licence and Licence to Start Operations), besides submitting the documents required for the construction license, the following additional documents must be also submitted

d) Data from the verification tests carried out in order to establish that operations can start
e) Details on professional background and experience of personnel carrying out verification tests
f) Certification of the equipment employed to carry out verification tests.
g) Information on personnel training, including training programmes for different staff bands, safety manual or safety regulations, and emergency procedures.

Annex 4 Application Guidelines for Requesting an Environmental Licence When Setting Up a New Laboratory or Facility

Each of the headings below must be addressed in full, employing as many pages as it may be necessary, and indicating on each page the Annex Number and corresponding heading.

An original and a copy must be submitted.

1. Name of the project or activity.
2. Name of the applicant, nationality, address, and telephone and fax numbers.
3. Name of the project or activity leader.
4. Macro-location: A copy of the official report from the Land Planning Office must be enclosed when relevant.
5. Micro-location of new buildings or of any existing facilities which are subject to changes in the use or in the level of use, or any other modifications or extensions: A copy of the official micro-location report approved by the Land Planning Office (of the corresponding Province) must be enclosed when relevant. Similarly, when relevant, a copy of the certificate of mining rights must be enclosed.
6. Map coordinates of the benchmarks of the project or activity area: The flat X and Y coordinates of the benchmarks included in the project must be submitted. It is possible that these may be one point.
7. Budget: Breakdown and currency.
8. General environmental and socio-economic features of the area where the project or activity is planned: Comprehensive qualitative and quantitative description of the flora, fauna, soils, relief, water and air. Special attention must be given to socio-economic factors in general, with particular analysis of factors which may affect health, education and traditional lifestyles.
9. Quality of air, water, soil and the biome: Qualitative and quantitative information must be separately provided on the quality of air, land water (subterraneous and surface) and sea water, soils and biome.
10. Description of options under consideration regarding the project development (including its location): This must cover the full period ranging from the selection of the project or activity site to its final decommissioning. It should also provide details on the area required, the building programme, the start of operations, the operations themselves, the type of activity, and a qualitative and quantitative description of the natural resources and raw materials and technologies which will be employed, as well as the estimated production levels and budgets. Special mention must be made to the projected water consumption, and the source of this water.
11. Description of the effluents: Highlight key parameters or indicators employed to measure pollution level. Quantitative and qualitative data on the composition and quantity of effluents, gas emissions and solid residues which will be disposed of in the environment during the construction and operation of the

project must be provided. In the case of effluents, the levels of parameters such as DB05, DQO, pathogens, nutrients, pH, heavy metals, hydrocarbons, suspended solids, etc. (as may be relevant) must be highlighted. In the case of gas emissions, the emphasis must be on the concentration levels of NOx, SOx and particulates, while in the case of solid residues in general, composition must be provided.

12. In cases where the drains are connected to systems for residues treatment: besides describing their components, outline their design capacity, utilized capacity, real removal efficiency, and characterization of the effluent, as well as the projected final layout.

13. Technologies to be employed, and degree to which clean production is envisaged, including the reduction in, and safe use of residues, and a detailed description of the production flow. Comments must be included on how these satisfy regulations on the import or transfer of nominal or not nominal technologies.

14. If the planned project or activity is expected to generate toxic chemicals or residues, this must be clearly highlighted. A detailed description of the transport operations, storage and handling of these products or residues must be given. Specific information must be provided on the use of, and quantity of any substances which, if leaked, could have serious detrimental effects on the environment or human health.

15. Identification and description of foreseen environmental impacts: Identify, describe and assess any positive or negative environmental impacts associated with the various stages of the project. Special emphasis must be given to the identification of the impact of residues.

16. Measures to prevent and minimize detrimental environmental impact: Outline the measures which will be taken to prevent and minimize expected detrimental environmental impacts during each of the stages of the project. Particular attention must be paid to the impact of residues. When relevant, the measures to be taken on decommissioning or closure of the project must also be discussed.

17. Planned measures after the final decommissioning or closure of the project or activity: Describe the measures to take should any detrimental environmental effects persist once the activities which have generated them have ceased.

18. Accident and contingency plans: Identify actions planned in case of accident or emergency, and their range/scope.

19. Provide documentation on the information which has been provided to the public with regard to the project and its potential implications, and of any required public consultation in accordance with the methodologies employed by the Environmental Inspection and Control Centre.

20. Monitoring programme: Outline the factors to be controlled, and the monitoring frequency, specifying:

    a) Sampling design and method, including biophysical and social aspects

    b) Resources, measures, periodicity, responsibility and budget.

Annex 5 Information Required for Obtaining a Licence for Importing and Exporting from External Quarantine

Information required for the IMPORT licence for biological pesticides

- Name and address of importer
- Foreign Trade Ministry Licence
- Name of the product
- Origin/provenance
- Point of departure
- Import route
- Name of the arrival dockyard or airport
- Expected date of arrival
- Purpose (consumption, reproduction, raw material, research)
- Data on original culture, including culture medium, materials, and source from which it was isolated or obtained.

Information required for the EXPORT licence for biological pesticides

- Name and address of exporter
- Foreign Trade Ministry Licence
- Name and origin/provenance of the material(s) under quarantine
- Estimated date of departure
- Number of units or items by strains or batches
- Destination
- Outgoing dockyard or airport
- Plant pathology requirements of the importing country
- Official certification from the Scientific or Manufacturing Institution authorizing and guaranteeing the source data, including the culture media and materials, and the source from which it was obtained.

Annex 6 Official Registration Application

Republic of Cuba

Ministry of Agriculture

Register of Pesticides

Application No._____

To the General Director of Plant Pathology:

I, _____(name)

at _____(address)

in my capacity as _____(position)

and in accordance with the regulations on pesticides in force in Cuba, wish to apply for the registration of the product described below:

1 Commercial name _____
2 Type of formulation _____
3 Name and address of manufacturer _____
4. Name and address of distributor _____
5 Common name of the active ingredient _____
6 Functional classification _____
7 Biological activity _____
8 Action mechanism _____
9 Storage requirements _____
10 Duration of guarantee _____
11 Proposed use(s) _____
12 Samples to be provided _____

I enclose the following documentation in Spanish:

- Power of Attorney as representative of the applicant institution
- Technical information on the commercial product and active ingredient
- Safety record
- Projected labelling
- List of countries where this product is authorized, providing registration numbers and uses.

I agree to provide any additional information which may be required in order to complete this product's assessment.

Date _____ Location _____ Signature _____

Annex 7 Addresses, Emails and Telephone Numbers of Relevant Institutions

National Plant Pathology Centre
The Director, National Plant Pathology Centre
Ayuntamiento 31 entre San Pedro y Lombillo
Municipio Plaza de la Revolucion
Ciudad Habana, Cuba
Email: cnsv@ceniai.inf.cu
Tel: 53 (7) 79-1339; Fax: 53 (7) 70-3277

External Quarantine Department
Head of Department
Tel: 53 (7) 79-1634, 78-4976 (Ext: 116 117)

National Centre for Biological Safety
The Director, National Centre for Biological Safety
Calle 28 No. 502e/5ta y 7ta
Miramar, Municipio Playa
Ciudad Habana, Cuba
Email: cns@unepnet.inf.cu
Tel: 53 (7) 23-8040,22-3281

Centre for Environmental Inspection and Control
The Director, Centre for Environmental Inspection and Control
Calle 20 esq a 18A, Municipio Playa
Ciudad Habana, Cuba
Tel: 53 (7) 2-7573

National Toxicological Centre
The Director: National Toxicological Centre
Hospital Militar 'Carlos J Finlay'
Ave 114 y 31, Municipio Marianao
Ciudad Habana, Cuba
Tel: 53 (7) 260-3252

Discussion

Comment
Researchers who have candidate biopesticides that are showing promise should approach the advisory commission who will then recommend either fast backing on safety data, justifies or determines what further toxicological studies must be carried out to progress registration.

Question
What is the cost of registration?

Answer
It is not expensive, NOT like the European Union cost approx. 10,000 pesos.

Question
The species of fungus being developed in Cuba for root-knot nematode control has been found in Kenya, but the Kenyan isolate is genetically distinct. Would the Kenyan authorities take notice of the toxicology tests done in Cuba or require new tests for the Kenyan isolate?

Answer
As the mode of action of both isolates is similar, new tests would not be required, as long as the toxicological data from Cuba are freely available.

Working Groups

Following the presentations, the participants split into three working groups:

- Macrobials (natural enemies)
- Microbials
- Botanicals.

The groups discussed the requirements for registering each group using the Pest Control Products Act Cap 346, 1982, Kenya, requirements as a template and their own expert knowledge and experience from other regions. Their advice and deliberations resulted in the amendments to the Pest Control Products Act guidelines which are provided in Annexes 1, 2 and 3.

Closing Speech

Dr Romano M. Kiome
Director, Kenya Agricultural Research Institute HQ
P.O. Box 57811, Nairobi, Kenya

Dr Frances Kimmins, DFID CPP Representative
Resource persons
Private sector representatives
Distinguished scientists
Participants
Ladies and Gentlemen

It is a great pleasure to be with you this morning at this Biopesticide Registration Workshop. I was unable to be with you on the first day due to pressing official engagements. I believe I was well represented by my Deputy Director in charge of Research and Technology, Dr Ephraim Mukisira.

As you are aware, the economies of many African countries depend heavily on agriculture. However, productivity in this sector is highly constrained by high cost of farm inputs, pests and diseases.

In Kenya, agriculture contributes 30% to the Gross Domestic Product (GDP), provides food for 30 million people and creates employment for more than two million people at the farm level, and in the transport and manufacturing sectors. Of the available land mass of 572,000 square metres, 80% is arid and semi-arid, while 20% is suitable for arable agriculture. With a population of 30 million, 90% of whom live in rural areas, and the increasing demand for food and raw materials for manufacturing industries, there is increasing pressure on the available arable land.

Ladies and Gentlemen, intensive agriculture production leads to build up of pests and diseases for crop, livestock and man as well as environmental degradation. Control of these pests is essential for sustainable agricultural production. Currently Kenya spends KSh 4 billion on importation of pesticides for this purpose. This is expensive to the national economy. Development of resistance to pesticides, environmental pollution, public health risks and pesticide residues clearly makes reliance on synthetic chemicals for pest control unsustainable. On top of this the cost of research and development into new synthetic pesticides is becoming prohibitive and companies are looking for new opportunities.

Research and development in various parts of the world in search of alternatives to synthetic chemicals is yielding promising results with the use of biological products such as bacteria, viruses, fungi, nematodes, protozoa, parasitoids predators whose manufacture, distribution and use are well documented in the US and EU. However, there is no legal framework in this country to govern the production and use of biopesticides. There is therefore a need to develop guidelines and regulations for effective management of these new products.

I wish therefore to congratulate DFID Crop Protection Programme for supporting this workshop to develop the registration guidelines of biopesticides in Kenya. I am

informed that the workshop has discussed a wide range of topics involving research and commercial production of biopesticides as well as the registration requirements that have to be fulfilled before the use of these products for pest control is allowed. I believe the experience gathered at this meeting will help to develop guidelines for the regulation of biopesticides use in Kenya and the East African region. I promise this meeting that your recommendations will be passed on to the relevant authorities for further action. This will provide the enabling policy environment to commercialize the biopesticides in Kenya.

With these few remarks, it is now my great pleasure to declare the Biopesticide Workshop officially closed.

Annexes

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Annex 1 Application for the Registration of a Microbial Pest Control Product

FORM A2.1

PEST CONTROL PRODUCTS ACT, CAP 346, 1982
KENYA

APPLICATION FOR THE REGISTRATION OF A MICROBIAL PEST CONTROL PRODUCT

INTRODUCTION

1. These guidelines are for any proposed use of naturally occurring bacteria, protozoa, fungi, viruses, rickettsia, for the control of invertebrate pests, weeds, plant parasitic nematodes or microbial pathogens of crops. The use of microbial agents for the control of vertebrate pests is not contemplated. Nematodes are handled as macrobial biopesticides.
2. Information in support of a request for registration, both published and unpublished (fully cited) should be supplied in the form of a summary data sheet laid out according to the format given in Form A2.1.
3. A pre-registration consultation between the applicant and the registration authority is strongly recommended.

Information for Applicants

1. The application form must be completed by a person duly authorized by the applicant/company.
2. The application must be submitted in triplicate to: The Secretary, Pest Control Products Board (PCPB) P.O. Box 13794, Nairobi
   e-mail address pcpboard@todays.co.ke or pcpboard@nbnet.co.ke
   Tel 254-20-4446115, Fax 254-20-4449072.
3. Every application must be accompanied by:
   a. registration fee as prescribed
   b. 3 copies of the draft label as per PCPB requirements.
4. The applicant shall be required to submit:
   a. a sample of the pest control product
   b. a sample of the technical grade of its active agent
   c. a sample of the laboratory standard of its active agent
   d. any other sample as may be required by PCPB.
5. All applicants intending to import/export live organisms into or out of the country should seek clearance from the Kenya Standing Technical Committee on Imports and Exports on live organisms (KSTCIE).
6. The use of genetically modified organisms (GMOs) and living modified organisms (LMOs) for use as microbial biopesticides should be cleared by the National Biosafety Committee on GMOs before an application is made. Genetically modified crops are handled by the National Biosafety Committee.
7. List MI and MII are supplied as check lists and an index to ensure that the applicant has provided all relevant data and all cited material.
8. The application must be accompanied by a technical dossier as per PCPB data requirements i.e. Lists MI and MII.
9. An applicant who is not a resident in Kenya must appoint an agent permanently resident in Kenya

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PURPOSE OF APPLICATION (tick as appropriate)

a. Biopesticides containing a new active agent	☐
b. Biopesticides where source of active and/or formulation is not identical to that of a registered product	☐
c. Registration transfer	☐
d. Amendments to existing registration	☐
e. Other (explain)	
Will the product be marketed under own label? Yes ☐ No ☐ If No, specify ……	

1. APPLICANT

1.1 Name of applicant		
1.2 Corporate name of company		
1.3 Reg No.		
1.4 Name of registration holder		
1.5 Name of local agent in country (if different from registration holder)		
1.6 Status (importer/formulator/distributor etc.)		
1.7 Physical address		
1.8 Postal address		
1.9 Telephone (and area code)		
Fax (and area code)		
E-mail		

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2. PRODUCT

2.1 Identity and stage(s) of active agent and culture collection code			
2.2 Concentration of active agent in technical material			
2.3 Designation (description of product)	Trade name:		
	Trade mark:		
	Trade mark holder:		
	Internal code:		
2.4 Function of product: (e.g. Insecticide, herbicide etc.)			
2.5 Intended use: (veterinary, horticultural, public health, industrial, agriculture, forestry etc.)			
2.6 Target pest(s) and host(s)			
2.7 Method, dosage rates and frequency of application			
2.8 Type of formulation: (e.g. suspension, WP*, etc.)			
2.9 Is the product registered in country of: a) origin	Yes ☐ No ☐ If no, specify ……		
b) manufacture	Yes ☐ No ☐ If no, specify ……		
c) formulation	Yes ☐ No ☐ If no, specify ……		
2.10 Registration in SEARCH country/ies (country names, product name and registration number)			
2.11 Registration in other country/ies, particularly OECD countries (country names, product name and registration number)			
2.12 Customs Tariff Code: (Brussels Tariff Nomenclature)			

3. IDENTIFICATION

Identification of micro-organism	Life stage (spore, hyphae etc)		
3.1 Identification	Genus	Species	Sub species
Scientific name			
Common name(s)			
3.2 Contents (number per unit)			

* Acronyms and abbreviations can be found at the end this document (Annex 1)

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4. COMPOSITION OF MICROBIAL PEST CONTROL AGENT(S) (Technical grade)

(Information on active agent may be attached in sealed envelope)

Active agent(s) common name(s)	Manufacturer (name and address)	Minimum a.a.% purity	a.a. range %

5. FORMULATION

5.1 Formulator (name):	Postal address:
Internal code:	Physical address:

5.2 Composition (Information on composition may be attached in sealed envelope)

Ingredients and function	Units (w/w, w/v etc.)	Units (e.g. cfu or IUP)	Range

6. BIOLOGICAL PROPERTIES OF ACTIVE AGENT

6.1 History and geographical distribution of active agent	
6.2 Mode of action and host range	
6.3 Life cycle	
5.4 Infectivity, dispersal and colonizing ability	
5.5 Relationships to known plant, animal or human pathogens	
5.6 Genetic stability	
5.7 Information on the production of metabolites, especially antibiotics and toxins	

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7. TOXICOLOGY (active agent)

7.1 Rat:	Acute oral (LD_{50} mg/kg)	Inhalation LC_{50} (mg/l/4 hour)	Intra-peritoneal injection for infectivity (LD_{50} g/kg)
	Experimental	Experimental	Experimental
	Calculated	Calculated	Calculated
7.2 Hypersensitivity/ allergies in humans			

8. TOXICOLOGY (formulated product)

8.1 Rat	Acute oral (LD_{50} mg/kg)	Acute dermal (LD_{50} g/kg)	Inhalation LC_{50} (mg/l/4 hour)
	Experimental	Experimental	Experimental
	Calculated	Calculated	Calculated
8.2 Rabbit	Skin irritation	Eye irritation	
None			
Mild			
Moderate			
Severe			
8.3 Skin sensitization in guinea pig (tick)		None Mild Moderate Severe	

8.4 WHO classification (tick)	Ia	Ib	II	III	Others
8.5 Summary of other mammalian toxicological studies: e.g. livestock, wildlife, poultry, pets					

9. ECOTOXICOLOGY

9.1 Toxicity to bees	
9.2 Toxicity to fish and other aquatic organisms	
9.3 Toxicity to birds	
9.4 Toxicity to earthworms or other soil invertebrates, and soil micro-organisms	
9.5 Toxicity to other non-target organisms	
9.6 Persistence in environment	
9.7 Available toxicological data relating to other ingredients in formulation (non-active additives in formulation)	
9.8 Other effects: specify	

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10. PACKAGING

10.1 Packaging material/container	
10.2 Pack size(s)	
10.3 Disposal of empty container(s)	

11. OTHER SPECIFIC REQUIREMENTS

11.1 Operator exposure	
11.2 Sanitary and phytosanitary measures	
11.3 Has the product been cleared by the phytosanitary authorities? (tick): a) in the country of origin b) in the recipient country	Yes (provide evidence) ☐ ☐ No (give reasons) ☐ ☐

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12. DECLARATION

<table>
<tr><td colspan="2">For and on behalf of ……..……., I hereby certify that the above mentioned information and data provided in support of this application are to the best of my knowledge true, correct and complete.</td></tr>
<tr><td>……..
Name in full (printed)</td><td>……
Signature</td></tr>
<tr><td>……..……
Official Title</td><td>……
Date</td></tr>
<tr><td>Official Stamp
of Applicant/Company</td><td>FOR OFFICIAL USE

Remarks
……..
……..….
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Signed: Date:</td></tr>
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NOTE: The format of this application form is recognized by all SEARCH countries.

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FORM A2.1, LIST MI

ACTIVE AGENT: DOSSIER INDEX FOR A MICROBIAL PEST CONTROL AGENT

The dossier accompanying the application must provide full details (as applicable) of the information requested in this list, i.e. details of the methods used and results of toxicological and ecotoxicological studies, methods of analysis, etc. Numbering used in the dossier must correspond to that used in the application form. If the product contains more that one active agent, compile a separate dossier for each active agent.

1. DESIGNATION/IDENTITY OF ACTIVE AGENT (PURE)

	Annex No. in dossier if study included	Official use only
1.1 Common name		
1.2 Full taxonomic name including isolate, strain or subspecies (where appropriate)		
1.3 Full taxonomic classification		
1.4 Methods of identification, enumeration, and bioassay		
1.5 Manufacturer or development code		
1.6 Source, name and address of manufacturer and address and location of manufacturing plants		
1.7 Methods of production and quality control		
1.8 Collection and culture reference number where culture is deposited		
1.9 Patent status of formulation		
a) Is the product under patent?		
b) Who is patent holder?		
c) When was product patented?		
d) What is the expiry date of patent?		

2. BIOLOGICAL PROPERTIES OF THE MICRO-ORGANISM

	Annex No. in dossier if study included	Official use only
2.1 History of the micro-organism and its uses. Natural occurrence and geographical distribution		
2.2 Description of the target organism(s) and mode of action		
2.3 Host specificity range and effects on species other than the target harmful organism		
2.4 Development stages/life cycle of the micro-organism		
2.5 Infectivity, dispersal and colonization ability		

	Annex No. in dossier if study included	Official use only
2.6 Effect of environmental parameters (UV, temperature, soil pH, humidity, nutrition requirements, etc.) on stability and survival		
2.7 Relationships to known plant, animal or human pathogens		
2 8 Genetic stability and factors affecting it		
2.9 Information on the production of metabolites (especially toxins)		
2.10 Show antibiotics and other anti-microbial properties		

3. FURTHER INFORMATION ON THE MICRO-ORGANISM

	Annex No. in dossier if study included	Official use only
3.1 Biological function (control of insects, fungi, mites, ticks, bacteria, viruses, nematodes, weeds, molluscs, etc.)		
3.2 Information on the occurrence or potential development of resistance of the target organism(s) and resistance management strategy.		
3.3 Methods to prevent loss of virulence of seed stock of the micro-organism		
3.4 Recommended methods and precautions concerning handling, storage, transport etc.		
3.5 Procedures for destruction or decontamination		
3.6 Measures in case of an accidental spillage		

4. PHYSICAL AND CHEMICAL PROPERTIES (Active agent – technical grade)

	Annex No. in dossier if study included	Official use only
4.1 Physical state (liquid, solid etc.)		
4.2 Colour		
4.3 Odour		
4.4 Stability in water, air, effect of temperature, effect of light, identity of breakdown products		
4.5 Reactivity towards container material		

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5. TOXICOLOGY

Toxicological data may be waived where there is sufficient evidence that the product is safe. This would be based on results of medical surveillance, published data, as well as actual studies on the product. Where no evidence is provided, or where there is insufficient evidence, toxicological studies have to be conducted as indicated under Tier 1 in the first instance. Tier 2 is applied when, in the absence of evidence of pathogenicity, either toxicity or infectivity is observed in Tier 1. Tier 3 is applied when there are issues of known or suspected subchronic toxicity and human pathogenicity and tests for effects following long-term exposure and particular adverse effects of intracellular parasites of mammalian cells.

TIER 1 STUDIES (Active agent and/or technical grade)	**Annex No. in dossier if study included**	**Official use only**
5.1 Medical surveillance data for manufacturing plant and agricultural workers (such as occurrence of hypersensitivity/allergies)		
5.2 Acute oral LD_{50} mg/kg LC_{50} (rat/rabbit)		
5.3 Inhalation LC_{50} mg/l/4 hour (rat/rabbit)		
5.4 Mutagenicity/genotoxicity		
5.5 Intra-peritoneal (fungi and protozoa)/ intravenous (others) injection for infectivity		
5.6 Discussion of the effects of repeated human exposure		
5.7 Other studies		

TIER 2 STUDIES (Active agent and/or technical grade)	**Annex No. in dossier if study included**	**Official use only**
5.8 Subchronic toxicity 28 day NOEL mg/kg/day		

TIER 3 STUDIES (Active agent and/or technical grade)	**Annex No. in dossier if study included**	**Official use only**
5.9 Chronic toxicity/carcinogenicity NOEL mg/kg/day (mouse/rat)		
5.10 Neurotoxicity NOEL mg/kg/day		
5.11 Teratogenicity NOEL mg/kg/day		
5.12 Reproduction (rat/rabbit)		

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6. ECOTOXICOLOGY
(Active agent – technical grade)

Waivers may be granted on presentation of evidence that exposure to the particular non-target organism will not occur, or where effects of exposure are already documented. Selection of test non-target organisms will be on a case by case basis and according to mode of action and ecological relevance. TIER 1 studies should report any observed pathogenicity/infectivity to the test species. TIER 2 studies are required on representative non-target species if acute studies indicate that adverse effects would occur during routine application.

TIER 1		**Annex No. in dossier if study included**	**Official use only**
6.1 Birds (2 species)	LD_{50} mg/kg LD_{50} mg/kg		
6.2 Aquatic organisms (2 species)	LC_{50} mg/ml LC_{50} mg/ml		
6.3 Aquatic invertebrate	EC_{50} mg/ml		
6.4 Algae	EC_{50} mg/ml		
6.5 Bees	LD_{50} µg/bee		
6.6 Representative natural enemies	LD_{50} µg/ individual		
6.7 Earthworms or other relevant soil invertebrate (eg termites)	LC_{50} mg/kg		
6.8 Soil micro-organisms	EC_{50} mg/ml		
6.9 Representative non-target plant	LC_{50} mg/ml		

TIER 2		**Annex No. in dossier if study included**	**Official use only**
6.10 Birds (1 species)	Reproduction		
	NOEL		
6.11 Aquatic organisms (2 species)	Reproduction		
	BCF		
	NOEL		
	Reproduction		
	BCF		
	NOEL		

7. BEHAVIOUR IN ENVIRONMENT
(Active agent – technical grade)

	Annex No. in dossier if study included	**Official use only**
Behaviour in soil		
7.1 Persistence of active agent (days)		
7.2 Mobility of active agent		
7.3 Major metabolites where appropriate		
Behaviour in surface and ground water		
7.4 Persistence of active agent (days)		
7.5 Major metabolites where appropriate		

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8. RESIDUES

	Annex No. in dossier if study included	Official use only
8.1 Identity of residues		
8.2 Level and behaviour of residues		
8.3 Major metabolites/agents (viable and non-viable)		
8.4 PHI, withholding periods in case of post-harvest use		
8.5 Method of residue analysis		

9. OTHER SPECIFIC REQUIREMENTS

	Annex No. in dossier if study included	Official use only
9.1 Residue data from a GLP certified lab or as directed by the Secretary PCPB		
9.2 Effects on taint, odour, taste or other quality aspects due to residues in or on fresh or processed products (where appropriate)		
9.3 Effects on industrial processing and/or household preparation on the nature and magnitude of residues (where appropriate)		
9.4 Residue data in succeeding or rotational crops where presence of residues might be expected (where appropriate)		
9.5 Assessment of the likely residue levels encountered by persons handling treated produce		

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FORM A2.1, LIST MII

FORMULATED PRODUCT: DOSSIER INDEX FOR A MICROBIAL PEST CONTROL PRODUCT

The dossier accompanying the form should provide more details of the information requested in this list. Summaries of the methods and results used in toxicological and ecotoxicological studies, methods of analysis etc. Numbering used in the dossier must correspond with that used in the application Form A2.1.

1. IDENTITY

	Annex No. in dossier if study included	Official use only
1.1 Formulation type and code		
1.2 Source and specifications for components included in the formulation		
1.3 Methods of identification, enumeration, and bioassay		
1.4 Material safety data sheet for formulation and each co-formulant		

2. PHYSICAL AND CHEMICAL PROPERTIES

	Annex No. in dossier if study included	Official use only
2.1 Physical state (solid, liquid etc.)		
2.2 Colour		
2.3 Odour		
2.4 Effects of light, air, temperature, water on technical characteristics of the formulation		
2.5 Storage stability in proposed packaging		
2.6 Shelf life		
2.7 Density		
2.8 Bulk density		
2.9 Flammability		
2.10 Compatibility with other pesticides		
2.11 pH		
2.12 pH of 1% aqueous dilution		
2.13 Oxidizing properties		
2.14 Water content		
2.15 Wettability		
2.16 Solubility in water		

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	Annex No. in dossier if study included	Official use only
2.17 Persistent foaming		
2.18 Particle size		
2.19 Wet or dry sieve test as appropriate		
2.20 Suspensibility/emulsifiability		
2.21 Emulsion stability		
2.22 Viscosity		
2.22 Other properties (e.g. adherence to seeds for seed dressings)		

Note: This information is required as applicable to the formulation type

3. TOXICOLOGY

	Annex No. in dossier if study included	Official use only
3.1 Rat Acute oral LD_{50} mg/kg		
3.2 Rat Acute dermal LD_{50} mg/kg		
3.3 Rat Acute inhalation LC_{50} mg/l/4 hour		
3.4 Rabbit Skin irritation		
3.5 Rabbit Eye irritation		
3.6 Skin sensitization in guinea pig		
3.7 WHO classification		
3.8 Other studies (if applicable)		

4. EMERGENCY PROCEDURES IN CASE OF ACCIDENTAL EXPOSURE OR POISONING

	Annex No. in dossier if study included	Official use only
4.1 Symptoms of human poisoning		
4.2 Mode of action in man		
4.3 First aid treatment		
4.4 Skin contact		
4.5 Eye contact		
4.6 Inhalation		
4.7 Ingestion		
4.8 Antidote		
4.9 Note to physician		

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5. EMERGENCY PROCEDURES IN CASE OF FIRE/SPILLAGE

	Annex No. in dossier if study included	Official use only
5.1 Fire fighting measures		
5.2 Procedures in case of spillage		

6. INTENDED USES (New label claims with this application)

	Annex No. in dossier if study included	Official use only
6.1 Function (control of insects, fungi, mites, ticks, bacteria, viruses, nematodes, weed, molluscs, etc.)		
6.2 Target pest(s)		
6.3 Area of use		
6.4 Application rate (appropriate units and cfu)		
6.5 Method of application		
6.6 Recommended number and timing of applications		
6.7 Stage of treatment		
6.8 Directions for use		
6.9 Residue data and PHI		
6.10 Phytotoxicity		
6.11 Contraindications		
6.12 Local Biological Efficacy data (guidelines provided separately)		

7. MINIMUM LABEL REQUIREMENTS – (provided separately)

To be developed

8. REGISTRATION IN OTHER COUNTRIES

	Annex No. in dossier if study included	Official use only
8.1 Evidence of registration in other countries		

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9. OTHER SPECIFIC REQUIREMENTS

	Annex No. in dossier if study included	Official use only
9.1 Medical surveillance on manufacturing plant personnel		
9.2 Health records of occupationally exposed personnel, industry, agriculture, forestry, fisheries		

10. PROPOSED PACKAGING

	Annex No. in dossier if study included	Official use only
10.1 Type of packaging in which the product is imported		
10.2 Type of packaging for distribution in Kenya		
10.3 Packaging material		
10.4 Sizes of individual packaging		

11. PROCEDURES FOR DESTRUCTION AND DECONTAMINATION

	Annex No. in dossier if study included	Official use only
11.1 Possibility of neutralization		
11.2 Controlled discharge		
11.3 Controlled incineration		
11.4 Water purification		
11.5 Procedures of cleaning application equipment		
11.6 Recommended methods and precautions concerning handling during storage, display or transport		

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GUIDELINE: DOSSIER FOR A MICROBIAL PEST CONTROL AGENT

The dossier accompanying this form should provide details of the information requested. Methods used (physical and chemical), details of the methods used in and results of toxicological and ecotoxicological studies, methods of analysis etc. have to be given. Numbering used in the dossier must correspond with that used in the application form.

ACTIVE INGREDIENT/AGENT
(Technical grade)

REQUIREMENTS	REMARKS
1.1 Common name (ISO)	Indicate where applicable
1.2. Full taxonomic name including isolate, strain or subspp. (where appropriate)	Full scientific name including any relevant information
1.3 Full taxonomic classification	Indicate full systemic classification including any relevant information
1.4 Methods of identification, enumeration, and bioassay	Give morphology, histology, molecular biolgy, methodof counting microbes per unit volume/weight, etc.
1.5 Manufacturer or development code	Specify source/manufacturer
1.6 Source, name and address of manufacturer and address and location of manufacturing plants	Indicate company and country of origin Name, address, location of manufacturing plant
1.7 Methods of production and quality control	Developer will outline how the microbial agent is isolated, purified, bulked, quality control, and maintenance and assay methods
1.8 Collection and culture reference number where culture is deposited	Agent is to be deposited in a recognized culture collection, the name of the collection and the culture reference number is to be given
1.9 Patent status of formulation	
a) Is the agent under patent?	
b) Who is patent holder?	
c) When was the product patented?	
d) What is the expiry date of the patent?	

2. BIOLOGICAL PROPERTIES OF THE MICRO-ORGANISM

REQUIREMENTS	REMARKS
2.1 History of the micro-organism and its uses, natural occurrence and geographical distribution	The geographical region and the place in the ecosystem (e.g. host plant, host animal, or soil from which the micro-organism was isolated) must be stated. The method of isolation of the micro-organism should be reported. The natural occurrence of the micro-organism in the relevant environment shall be given if possible at strain level. Indicate whether the micro-organism has been GRAS (generally regarded as safe) listed.

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REQUIREMENTS	REMARKS
2.2 Description of the target organism(s) and mode of action	The principal mode of action should be indicated and if the micro-organism produces a toxin with a residual effect on the target organism, then the mode of action of this toxin should be described. If relevant, information on the site of infection and mode of entry into the target organism and its susceptible stages should be given. The results of any experimental studies must be reported. It must also be stated whether or not the micro-organism or its metabolites are translocated in plants and, where relevant, how this translocation takes place.
	In case of pathogenic effect on the target organism, infective dose (the dose needed to cause infection with the intended effect on a target species) and transmissibility (possibility of spread of the micro-organism in the target population, but also from one target species to another target species) after application under the proposed condition of use shall be indicated.
2.3 Host specificity range and effects on species other than the target harmful organism	Any available information on the effects of the micro-organism on non-target organisms within the area to which the micro-organism may spread shall be given. The occurrence of non-target organisms being either closely related to the target species or being especially exposed shall be indicated.
2.4 Development stages/life cycle of the micro-organism	Information on the life cycle of the micro-organism described, including symbiosis, parasitism, competitors, etc., on the target host organisms, as well as vectors for viruses, must be presented. The generation time and the type of reproduction of the micro-organism must be stated. Information on the occurrence of resting stages and their survival time, their virulence and infection potential must be provided.
2.5 Infectivity, dispersal and colonization ability	Information is to be provided on the behaviour of the micro-organism under typical environmental conditions of use and compared to the environmental conditions, if any, under which the micro-organism may infect, colonize or damage mammalian tissues Information on possible dispersal routes of the micro-organism (via air as dust particles or aerosols, with host organisms as vectors, etc.), under typical environmental conditions relevant to the use, must be provided
2.6 Effect of environmental parameters (UV, temperature, soil pH, humidity, nutrition requirements etc.) on stability and survival	The persistence of the micro-organism and its toxins under the typical environmental conditions of use must be indicated. Any particular sensitivity to certain components of the environment (e.g. UV light, soil, water) must be stated. The environmental requirements for survival, reproduction, and effectiveness of the micro-organism must be stated.

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REQUIREMENTS	REMARKS
2.7 Relationships to known plant, animal or human pathogens	The possible existence of one or more species of the genus of the active agent and/or, where relevant, contaminating micro-organisms known to be pathogenic to humans, animals, crops or other non-target species and the type of disease caused by them shall be indicated. It shall be stated whether it is possible, and by which means, to clearly distinguish the active micro-organism from the pathogenic species.
2.8 Genetic stability and factors affecting it	Where appropriate, information on genetic stability (e.g. mutation rate of traits related to the mode of action or uptake of exogenous genetic material) under the environmental conditions of proposed use must be provided. Information must also be provided on the micro-organism's capacity to transfer genetic material to other organisms as well as its capacity to being pathogenic for plants, animals or man.
2.9 Information on the production of metabolites (especially toxins)	If other strains belonging to the same microbial species as the strain subject to the application are known to produce metabolites (especially toxins) with unacceptable effects on human health and/or the environment during or after application, the nature and structure of this substance, its presence inside or outside the cell and its stability, its mode of action (including external and internal factors of the micro-organism necessary to action) as well as its effect on humans, animals or other non-target species shall be provided. The conditions under which the micro-organism produces the metabolite(s) (especially toxin(s)) must be described. Any available information on the mechanism by which the micro-organisms regulate the production of the(se) metabolite(s) should be provided. Any available information on the influence of the produced metabolites on the micro-organism's mode of action should be provided.
2.10 Antibiotics and other anti-microbial agents	Some micro-organisms produce antibiotic substances which may interfere with the use of antibiotics in human and veterinary medicine. This must be avoided at any stage of the development of a microbial plant protection product. Information on the micro-organism's resistance or sensitivity to antibiotics or other anti-microbial agents must be provided, in particular the stability of the genes coding for antibiotic resistance, unless it can be justified that the micro-organism has no harmful effects on human or animal health, or that it cannot transfer its resistance to antibiotics or other anti-microbial agents.

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3. FURTHER INFORMATION ON THE MICRO-ORGANISM

REQUIREMENTS	REMARKS
3.1 Biological function (control of insects, fungi, mites, bacteria, plant pathogens, nematodes, weed, molluscs, etc.)	The biological function must be specified.
3.2 Information on the occurrence or possible occurrence of the development of resistance of the target organism(s) and resistance management strategy	Available information on the possible occurrence of the development of resistance or cross-resistance of the target organism(s) must be provided. Where possible, appropriate management strategies should be described.
3.3 Methods to prevent loss of virulence of seed stock of the micro-organism	Methods to prevent loss of virulence of starting cultures are to be provided. In addition, any method, if available, that could prevent the micro-organism from losing its effects on the target species must be described.
3.4 Recommended methods and precautions concerning handling, storage, transport, etc.	Provide information that would be required for safe handling.
3.5 Procedures for destruction or decontamination	In many cases the preferred or sole means of safe disposal of micro-organisms, contaminated materials, or contaminated packaging, is through controlled incineration. Methods to dispose safely of the micro-organism or, where necessary, to kill it prior to disposal, and methods to dispose of contaminated packaging and contaminated materials, must be fully described. Data must be provided for such methods to establish their effectiveness and safety.
3.6 Measures in case of an accidental spillage	Information on procedures for rendering the micro-organism harmless in the environment (e.g. water or soil) in case of an accidental spillage must be provided.

4. PHYSICAL AND CHEMICAL PROPERITES

REQUIREMENTS	REMARKS
4.1 Physical state (liquid, solid etc.)	State whether powder, liquid or solid
4.2 Colour	Specify
4.3 Odour	If applicable
4.4 Stability in water, effect of light, identity of breakdown products	Provide information with evidence
4.5 Reactivity towards container material	Provide information with evidence

5. TOXICOLOGY
(Active Ingredient – technical grade)

Include a copy of an executive summary discussing **ALL ISSUES** named under Section 3 of the form or provide copies of the individual summaries from each study relating to issues mentioned under Section 3 of the form. Information on the methods of testing used must be provided.

TIER 1 STUDIES	
REQUIREMENTS	**REMARKS**
5.1 Medical surveillance data for manufacturing plant and agricultural workers (such as occurrence of hypersensitivity/allergies)	Available reports of occupational health surveillance programmes, must be submitted. These reports shall, where available, include data from persons exposed in manufacturing plants or after application of the micro-organism (e.g. in efficacy trials). Special attention should be devoted to those whose susceptibility may be affected, e.g. pre-existing disease, medication, compromised immunity, pregnancy or breast feeding. Available information on the sensitization and allergenic response of workers, including workers in manufacturing plants, agricultural and research workers and others exposed to the micro-organism must be provided, and include, where relevant, details of any incidences of hypersensitivity and chronic sensitization. Available reports from the open literature on the micro-organism or closely related members of the taxonomic group (relating to clinical cases), where they are from reference journals or official reports, must be submitted.
5.2 Acute oral LD_{50} mg/kg LC_{50} (rat/rabbit)	This should be provided for the technical grade for all kinds of agents listed in the application form.
5.3 Inhalation LC_{50} mg/l/4 hour (rat/rabbit)	Potential risks due to infectivity and pathogenicity should be given.
5.4 Mutagenicity/genotoxicity	If the micro-organism produces exotoxins, then these toxins and any other relevant metabolites in the culture medium must also be tested for genotoxicity. Such tests on toxins and metabolites should be performed using the purified chemical if possible. If toxic metabolites are not formed, studies on the micro-organism itself should be considered depending on expert judgement on their relevance. Genotoxicity of cellular micro-organisms should be studied after breaking of the cells where ever possible. In the case of a virus the risk of insertional mutagenesis in mammal cells or the risk of carcinogenicity has to be addressed.
5.5 Intra-peritoneal (fungi and protozoa)/intravenous (others) injection for infectivity	The intraperitoneal/subcutaneous test is considered a highly sensitive assay to elicit response in particular infectivity studies. The intraperitoneal injection is always required for all micro-organisms. However, expert judgement may be exercised to evaluate whether subcutaneous injection is preferred instead of intraperitoneal injection if the maximum temperature for growth and multiplication is lower than 37ºC.

TIER 1 STUDIES	
REQUIREMENTS	**REMARKS**
5.6 Discussion of the effects of repeated human exposure	Provide any available information on the subject
5.7 Other studies	Provide any available information on other studies

TIER 2 STUDIES (Active agent and/or technical grade)	
REQUIREMENTS	**REMARKS**
5.8 Subchronic toxicity 28 day NOEL mg/kg/day	Examine for toxicological and pathological changes in appropriate organs.

TIER 3 STUDIES (Active agent and/or technical grade)	
REQUIREMENTS	**REMARKS**
5.9 Chronic toxicity/carcinogenicity NOEL mg/kg/day (mouse/rat)	The assessment of risk from lifetime exposure to micro-organisms/toxins of concern may require examination for longterm toxicological and pathological changes in appropriate organs.
5.10 Neurotoxicity NOEL mg/kg/day	The assessment of risk from lifetime exposure to micro-organisms/toxins of concern may require examination for toxicological and pathological changes in nervous system.
5.11 Teratogenicity NOEL mg/kg/day	The assessment of risk from lifetime exposure to micro-organisms/toxins of concern may require examination of toxicological and pathological changes in appropriate organs.
5.12 Reproduction (rat/rabbit)	The assessment of risk from lifetime exposure to micro-organisms/toxins of concern may require examination of toxicological and pathological changes in the reproductive system.

Other studies

Provide further information relevant to the toxicity profile of the product e.g. toxicity of major metabolites, reaction or breakdown products of the pesticides formed in/or on treated plant/crop etc., which are likely to be consumed in cases where different from those identified in animal studies. Toxic effects on livestock, poultry, pets should be stated.

6. ECOTOXICOLOGY

Provide either an executive summary or individual summaries of studies on the behaviour in the environment providing information requested in the form.

TIER 1	
REQUIREMENTS	**REMARKS**
6.1 Birds (2 species)	Provide details of toxicity, infectivity and pathogenicity to at least one land and one water bird, LD_{50} in mg product and cfu or equivalent/kg bird weight.
6.2 Aquatic organisms Fish (2 species) Daphnia (1 species)	Provide details of toxicity, infectivity and pathogenicity to at least two species studied, LC_{50} (in mg of product and cfu or equivalent/litre of water)
6.3 Aquatic invertebrate	Specify and provide details on other organisms according to the information requested on the form.
6.4 Algae	

TIER 1	
REQUIREMENTS	**REMARKS**
6.5 Bees	
6.6 Representative natural enemies	
6.7 Earthworms or other relevant soil invertebrate (eg termites)	
6.8 Soil micro-organism	
6.9 Representative non-target plant	If the agent is closely related to a crop pathogen or a pathogen of a vertebrate species, laboratory evidence of genetic stability using appropriate tests is required.

TIER 2	
REQUIREMENTS	**REMARKS**
6.10 Birds (1 species)	Provide NOEL from one species studied and information on the effect on reproduction.
6.11 Aquatic organisms (2 species)	Provide NOEL details on at least two species studied and the effect on reproduction. Indicate the bioconcentration factor (BCF) on the active ingredient in tissues.

7. BEHAVIOUR IN ENVIRONMENT
(Active ingredient/agent – technical grade)

REQUIREMENTS	**REMARKS**
Behaviour in soil	
7.1 Persistence of active agent (days)	Indicate the degradation path of the active agent in the soil and the degradation products formed. Indicate also persistence and retention of biological activity.
7.2 Mobility of active agent	Indicate vertical and horizontal movement of agent in soil. Specify the degree of mobility of the active agent in the soil hence leaching potential and possibility for groundwater contamination.
7.3 Major metabolites where appropriate	Specify the major metabolites/ viable or non-viable residues in the soil and their behaviour
Behaviour in surface and ground water	
7.4 Persistence of active agent (days)	Describe ways and speed of degradation in surface and water
7.5 Major metabolites where appropriate	Specify the major break down products formed and their adsorption/desorption on sediments

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8. RESIDUES

REQUIREMENTS	REMARKS
8.1 Identity of residues	Specify
8.2 Level and behaviour of residues	Describe the process of metabolization of the active agent in the plant and the degradation products formed. Indicate the action and the persistence of the metabolites/agent/viable and non-viable residues in the plants and animals.
8.3 Major metabolites/agents (viable and non-viable)	Provide either an executive summary or individual summaries of studies conducted concerning the issues listed. Specify the metabolites/viable and non-viable residues. State their toxicological effects and retention of microbial activity.
8.4 PHI, withholding periods in case of post-harvest use	For each crop, state the Pre-Harvest Interval (PHI), and withholding period. State MRLs where applicable.
8.5 Method of residue analysis	Provide a copy in the dossier for countries requiring it.

Residue data have to be provided for bioproducts if they are found to have toxicological, infectivity and pathogenicity concerns to mammals.

9. OTHER SPECIFIC REQUIREMENTS

REQUIREMENTS	REMARKS
9.1 Residue data from a GLP certified laboratory or as directed by the Secretary, PCPB	Provide an executive summary or copies of summaries from each study relating to the issues highlighted in the form
9.2 Effects on taint, odour, taste or other quality aspects due to residues in or on fresh or processed products	Provide an executive summary or copies of summaries from each study relating to the issues highlighted in the form
9.3 Effects of industrial processing and/or household preparation on the nature and magnitude of residues	Provide an executive summary or copies of summaries from each study relating to the issues highlighted in the form
9.4 Residue data in succeeding rotational crops where presence of residues might be expected (where appropriate)	
9.5 Assessment of the likely residue levels encountered by persons handling treated produce	

***** For pest controlproducts found to have allergenic effects, detailed studies (on their residues) have to be provided.

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GUIDELINE: DOSSIER FOR A FORMULATED MICROBIAL PEST CONTROL PRODUCT

The dossier accompanying this form should provide details of the information requested. Methods used (physical and chemical), details of the methods used in and results of toxicological and ecotoxicological studies, methods of analysis etc. have to be given. Numbering used in the dossier must correspond with that used in the application form

1. IDENTITY

REQUIREMENTS	REMARKS
1.1 Formulation type and code	Provide information on the formulation type e.g. liquid concentrate, powder, etc.
1.2 Source and specifications for components included in the formulation	Geographical origin, company, reference laboratory
1.3 Methods of identification, quantification, and bioassay	Indicate procedures for identification and quantification of AI and impurities in the formulation
1.4 Material safety data sheet for formulation and each co-formulant	Provide information on safe handling, storage, transportation etc.

2. PHYSICAL AND CHEMICAL PROPERTIES

Clearly state method used to determine properties under the appropriate section of the dossier. CIPAC methods are recommended.

REQUIREMENTS	REMARKS
2.1 Physical state (solid, liquid etc.)	
2.2 Colour	
2.3 Odour	
2.4 Effects of light, air, temperature, water on technical characteristics of the formulation	Provide information with evidence
2.5 Storage stability in proposed packaging	Specify conditions for storage with evidence
2.6 Shelf life	Indicate production date and expiration date Provide supportive data
2.7 Density	Indicate the density of the liquids
2.8 Bulk density	Indicate the density of solids after compression
2.9 Flammability	Specify if product is flammable
2.10 Compatibility with other pesticides	Indicate types of pest control products which the product is or is not compatible with. Give evidence
2.11 pH	State the effect of pH on stability and effectiveness
2.12 pH of 1% aqueous dilution	Relevant to products to be diluted in water
2.13 Oxidizing properties	Indicate materials that can be damaged by oxidizing properties of the formulation
2.14 Water content	Indicate the maximum water content when it has an influence on the quality
2.15 Wettability	The wettability has to be indicated for solid formulations used in dilution (wettable powders, powder soluble in water and granules soluble in water)
2.16 Solubility in water	Specify

REQUIREMENTS	REMARKS
2.17 Persistent foaming	State the extent foaming occurs for formulations diluted in water
2.18 Particle size	Specify if applicable
2.19 Wet or dry sieve test as appropriate	Specify if applicable
2.20 Suspensibility/emulsifiability	Specify if applicable
2.21 Emulsion stability	Specify if applicable
2.22 Viscosity	Specify if applicable
2.22 Other properties (e.g. adherence to seeds for seed dressings)	Provide details

Other studies

Provide detailed studies on any other relevant toxicological or ecotoxicological studies conducted on the formulated product.

3. TOXICOLOGY

REQUIREMENTS	REMARKS
3.1 Rat Acute oral LD_{50} mg/kg	Provide details
3.2 Rat Acute dermal LD_{50} mg/kg	
3.3 Rat Acute inhalation LC_{50} mg/l/4 hour	
3.4 Rabbit Skin irritation	
3.5 Rabbit Eye irritation	
3.6 Skin sensitization in guinea pig	
3.7 WHO classification	
3.8 Other studies (if applicable)	

The dossier must contain a detailed Material Safety Data Sheet. Furthermore either an executive summary discussing all aspects mentioned under Section 3 must be included, or the summaries from each individual toxicity study and field in the same order.

The FAO/WHO class must be given as per the table hereunder.

WHO Classification Scheme

Class		LD_{50} for the rat (mg/kg body weight)			
		Solids	Liquids	Solids	Liquids
		Oral		Dermal	
Ia	Extremely hazardous	5 or less	20 or less	10 or less	40 or less
Ib	Highly hazardous	5–50	20–200	10–100	40–400
II	Moderately hazardous	50–500	200–2000	100–1000	400–4000
III	Slightly hazardous	Over 500	Over 2000	Over 1000	Over 4000

4. EMERGENCY MEASURES IN CASES OF ACCIDENTAL EXPOSURE OR POISONING

REQUIREMENTS	REMARKS
4.1 Symptoms of human poisoning	Provide details
4.2 Mode of action in man	
4.3 First aid treatment	
4.4 Skin contact	
4.5 Eye contact	
4.6 Inhalation	
4.7 Ingestion	
4.8 Antidote	
4.9 Note to physician	

5. EMERGENCY PROCEDURES IN CASE OF FIRE/SPILLAGE

REQUIREMENTS	REMARKS
5.1 Fire fighting measures	Specify
5.2 Procedures in case of spillage	

6. INTENDED USES

REQUIREMENTS	REMARKS
6.1 Function (control of insects, fungi, mites, ticks, bacteria, viruses, nematodes, weed, molluscs, etc.)	State whether it will be used as a fungicide, insecticide, etc.
6.2 Target pest(s)	Give name of target pest(s) and stage at which the biopesticide should be applied
6.3 Area of use	Specify (crops, livestock, public health, or environment)
6.4 Application rate (appropriate units and cfu)	Specify rate
6.5 Method of application	Specify
6.6 Recommended number and timing of applications	Specify timing and frequency
6.7 Stage of treatment	Specify growth stage of host
6.8 Directions for use	Specify on label and/or leaflet
6.9 Residue data and pre-harvest interval	Specify on label and/or leaflet
6.10 Phytotoxicity	Specify on label and/or leaflet
6.11 Contraindications	Specify on label and/or leaflet
6.12 Efficacy data (guidelines provided separately)	Provide from country of origin and other countries of similar climatic conditions in addition to the local data

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7. MINIMUM LABEL REQUIREMENTS

Specify the warnings, use restrictions and safety precautions which must be present on the label in all countries. The proposed label must be included in the dossier, should contain the specified warnings, use restrictions and safety precautions as well as meet PCPB label requirements. PCPB label requirements will be provided separately.

8. REGISTRATION IN OTHER COUNTRIES

REQUIREMENTS	REMARKS
8.1 Evidence of registration in other countries	Provide evidence

9. OTHER SPECIFIC REQUIREMENTS

REQUIREMENTS	REMARKS
9.1 Medical surveillance on manufacturing plant personnel	Provide details
9.2 Health records of occupationally exposed personnel, industry, agriculture, forestry, fisheries	Provide details

10. PROPOSED PACKAGING

REQUIREMENTS	REMARKS
10.1 Type of packaging in which the product is imported	Provide details
10.2 Type of packaging for distribution in Kenya	Provide details
10.3 Packaging material	Provide details
10.4 Sizes of individual packaging	Provide details

11. PROCEDURES FOR DESTRUCTION AND DECONTAMINATION

REQUIREMENTS	REMARKS
11.1 Possibility of neutralization	Provide details
11.2 Controlled discharge	Provide details
11.3 Controlled incineration	Provide details
11.4 Water purification	Provide details
11.5 Procedures of cleaning application equipment	Provide details
11.6 Recommended methods and precautions concerning handling during storage, display or transport	Provide details

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ACRONYMS and ABREVIATIONS

μg	microgram
a.a.	active agent
BCF	bio concentration factor
cfu	colony forming units
CIPAC	Collaborative International Pesticides Analytical Council
EC	emulsifiable concentrate
EC_{50}	median effective concentrate
FAO	Food and Agriculture Organization of the United Nations
g/kg	grams per kilogram
g//	grams per litre
GMOs	genetically modified organisms
GRAS	generally regarded as safe
ISO	International Standards Organization
IUP	International Unit of Purity
KSTCIE	Kenya Standing Technical Committee on Imports and Exports
LC_{50}	median lethal concentrate
LD_{50}	median lethal dose
LMOs	living modified organisms
mg/l	milligrams per litre
MSDS	material safety data sheet
NOEL	non observable effective level
^{o}C	degrees Celsius/centigrade
OECD	Organization for Economic Co-operation and Development
PCPB	Pest Control Products Board
PHI	pre-harvest interval
SEARCH	Southern and Eastern African Regulatory Committee on Harmonization of Pesticide Registration
WHO	World Health Organization
WP	wettable powder

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Annex 2 Application for the Registration of a Macrobial Pest Control Product

FORM A2.2

PEST CONTROL PRODUCTS ACT, CAP 346, 1982
KENYA

APPLICATION FOR THE REGISTRATION OF A MACROBIOL PEST CONTROL PRODUCT

INTRODUCTION

1. These guidelines are for any proposed use of naturally occurring predators, parasitoids and entomopathogenic nematodes for the control of weeds, invertebrate pests, or pathogens of crops and pests of livestock and public health.
2. Information in support of a request for registration, both published and unpublished (fully cited) should be supplied in the form of a summary data sheet laid out according to the format given in Form A2.2.
3. A pre-registration consultation between the applicant and the registration authority is strongly recommended.

Information for Applicants

1. The application form must be completed by a person duly authorized by the applicant/company.
2. The application must be submitted in triplicate to: The Secretary, Pest Control Products Board (PCPB) P.O. Box 13794, Nairobi
   E-mail address pcpboard@todays.co.ke or pcpboard@nbnet.co.ke
   Tel 254-20-4446115, Fax 254-20-4449072.
3. Every application must be accompanied by:
   a. registration fee as prescribed
   b. 3 copies of the draft label as per PCPB requirements.
4. The applicant shall be required to submit:
   a. a sample of the pest control product; with National Museums of Kenya or National Collection Number obtained if already in collection
   b. a sample of the technical grade of its active agent
   c. additional sample should be sent to NARL (KARI) and Biological Control Unit Muguga (KARI) and KEPHIS
   d. any other sample as may be required by PCPB.
5. All applicants intending to import/export live organisms into or out of the country should seek clearance from the Kenya Standing Technical Committee on Imports and Exports on live organisms (KSTCIE).
6. The use of genetically modified organisms (GMOs) and living modified organisms (LMOs) for use as microbial biopesticides should be cleared by the National Biosafety Committee on GMOs before an application is made. Genetically modified crops are handled by the National Biosafety Committee.
7. List MI and MII are supplied as check lists and an index to ensure that the applicant has provided all relevant data and all cited material.
8. The application must be accompanied by a technical dossier as per PCPB data requirements i.e. Lists MI and MII.
9. An applicant who is not a resident in Kenya must appoint an agent permanently resident in Kenya.

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PURPOSE OF APPLICATION (tick as appropriate)

a. Biopesticides containing a new active agent	☐
b. Biopesticides where source of active and/or formulation is not identical to that of a registered product	☐
c. Registration transfer	☐
d. Amendments to existing registration	☐
e. Other (explain)	
Will the product be marketed under own label? Yes ☐ No ☐ If No, specify ……	

1. APPLICANT

1.1 Name of applicant		
1.2 Corporate name of company		
1.3 Registration No. of the company		
1.4 Name of registration holder		
1.5 Name of local agent in country (if different from registration holder)		
1.6 Status (importer/formulator/distributor etc.)		
1.7 Physical address	1	2
1.8 Postal address	1	2
1.9 Telephone (and area code)	1	2
Fax (and area code)	1	2
E-mail	1	2

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2. PRODUCT

2.1 Identity and stage(s) of active agent and culture collection code			
2.2 Concentration of active agent in technical material			
2.3 Description of product	Trade name:		
	Trade mark:		
	Trade mark holder:		
	Internal code:		
2.4 Function of the product (e.g. predator, parasitoid, entomopathogenic nematode)			
2.5 Intended use (veterinary, horticultural, public health, industrial, agriculture, forestry, etc.)			
2.6 Target pest(s) and host(s)			
2.7 Method, dosage rates and frequency of application: a) production	Yes ☐ No ☐		
b) formulation (if any)	If no, specify …… Yes ☐ No ☐ If no, specify ……		
2.8 Type of formulation (if any)			
2.9 Is the product registered in country of: a) origin	Yes ☐ No ☐		
b) manufacture	If no, specify …… Yes ☐ No ☐		
c) formulation	If no, specify …… Yes ☐ No ☐ If no, specify ……		
2.10 Registration in SEARCH* country(ies) (country names, product name and registration number)			
2.11 Registration in other country(ies), particularly OECD countries (country names, product name and registration number)			
2.12 Customs Tariff Code: (Brussels Tariff Nomenclature)			

* Acronyms and abbreviations can be found at the end this document (Annex 2)

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3. IDENTIFICATION

Identification of macrobiol agent	Life stage (egg/adult larva etc)		
3.1 Identification Scientific name	Genus	Species	Sub species
Common name(s)			
3.2 Contents (number per unit)			

4. SOURCE

Source (original isolation**)**	

5. FORMULATION

5.1 Formulator (name):	Postal address: Physical address:
5.2 Internal code:	

5.3 Composition (information on composition may be attached in sealed envelope)		
Ingredients and function	Units	Range

6. SUMMARY OF ENVIRONMENTAL EFFECTS (BIOSAFETY)

6.1 Risk assessment for replacement of indigenous or endangered species in same niche (exotic macrobials only)	
6.2 Risk to bees	
6.3 Risk to fish and other aquatic organisms	
6.4 Risk to birds	
6.5 Risk to earthworms and soil micro-organisms	
6.6 Risk to other non-target organisms	
6.7 Other effects: specify (human health problems)	

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7. PACKAGING

7.1 Packaging material/container	
7.2 Pack size(s)	

8. OTHER SPECIFIC REQUIREMENTS

8.1 Operator exposure	
8.2 Likely operator exposure under field conditions	
8.3 Sanitary and phytosanitary measures	
8.4 Has the product been cleared by the phytosanitary authorities?	Yes ☐ No ☐

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9. DECLARATION

<table>
<tr><td colspan="2">For and on behalf of …… I hereby certify that the above mentioned information and data provided in support of this application are to the best of my knowledge true, correct and complete</td></tr>
<tr><td>……
Name in full (printed)</td><td>……
Signature</td></tr>
<tr><td>……
Official Title</td><td>……
Date</td></tr>
<tr><td>

Official Stamp of Applicant/Company</td><td>FOR OFFICIAL USE

Remarks:
.....
.....
.....
.....

Signed: .....Date:.....</td></tr>
</table>

NOTE: The format of this application form is recognized by all SEARCH countries.

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FORM A2.2, LIST MI

ACTIVE AGENT: DOSSIER INDEX FOR A MACROBIAL PEST CONTROL AGENT

The dossier accompanying the application must provide full details (as applicable) of the information requested in this list. Methods of identification should be provided. Numbering used in the dossier must correspond to that used in the application form. If the product contains more that one active agent, compile a separate dossier for each active agent.

1. DESIGNATION/IDENTITY OF ACTIVE AGENT (PURE)

	Annex No. in dossier if study included	Official use only
1.1 Common name		
1.2. Full taxonomic name including isolate, strain or subspecies (where appropriate)		
1.3 Full taxonomic classification		
1.4 Methods of identification, enumeration, etc.		
1.5 Manufacturer or development code		
1.6 Source, name and address of manufacturer and address and location of manufacturing plants		
1.7 Methods of production and quality control		
1.8 Collection and culture reference number where culture is deposited		
1.9 Patent status of production process		
a) Is the product under patent?		
b) Who is patent holder?		
c) When was product patented?		
d) Expiry date of patent		

2. BIOLOGICAL PROPERTIES OF THE MACROBIAL AGENTS

	Annex No. in dossier if study included	Official use only
2.1 History of the macro-organism and its uses. Natural occurrence and geographical distribution		
2.2 Description of the target organism(s) and mode of action		
2.3 Host specificity range and effects on species other than the target harmful organism		
2.4 Development stages/life cycle of the macro-organism		
2.5 Invasiveness, dispersal and colonization ability		
2.6 Effect of environmental parameters on stability and survival (UV, temperature, soil pH, humidity, etc.) of macrobial agents		

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	Annex No. in dossier if study included	**Official use only**
2.7 Relationships to known plant, animal or human parasites		
2 8 Genetic stability of macrobial agent and target crops		
2.9 Information on the production of metabolites (relevant to entomopathogenic nematodes)		

3. FURTHER INFORMATION ON THE MACRO-ORGANISM

	Annex No. in dossier if study included	**Official use only**
3.1 Biological function (control of insects, mites, ticks, nematodes, weeds, molluscs, etc.)		
3.2 Information on the occurrence or potential development of resistance of the target organism(s) and resistance management strategy		
3.3 Methods to prevent loss of predation or parasitic properties of the seed stock of the macro-organism		
3.4 Recommended methods and precautions concerning handling, storage, or transport		
3.5 Procedures for destruction or decontamination		
3.6 Measures in case of an accident		

4. BIOSAFETY

Hazard data may be waived where there is sufficient evidence that the product is safe. This would be based on results of medical surveillance, published data, as well as actual studies on the product.

(Active agent and/or technical grade)	**Annex No. in dossier if study included**	**Official use only**
4.1 Medical surveillance data for manufacturing plant and agricultural workers (such as occurrence of hypersensitivity/allergies)		
4.2 Discussion of the effects of repeated human exposure		
4.3 Other studies		

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5. ENVIRONMENTAL SAFETY

Waivers may be granted on presentation of evidence that exposure to the particular non-target organism will not occur, or where effects of exposure are already documented. Selection of test non-target organisms will be on a case-by-case basis and according to mode of action and ecological relevance.

	Annex No. in dossier if study included	**Official use only**
5.1 Aquatic organisms (2 species)		
5.3 Aquatic invertebrate		
5.4 Bees		
5.5 Representative natural enemies		
5.6 Representative non-target plant		

6. BEHAVIOUR IN ENVIRONMENT (Active agent)

	Annex No. in dossier if study included	**Official use only**
6.1 Persistence of active agent (days)		
6.2 Mobility of active agent		

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FORM A2.2, LIST MII

FORMULATED PRODUCT: DOSSIER INDEX FOR A MACROBIAL PEST CONTROL PRODUCT

The dossier accompanying the application must provide full details (as applicable) of the information requested in this list. Methods of identification and formulation of the macrobial biopesticide should be provided. Numbering used in the dossier must correspond to that used in the application form. If the product contains more that one active agent, compile a separate dossier for each active agent.

1. IDENTITY

	Annex No. in dossier if study included	Official use only
1.1 Formulation type and code		
1.2 Source and specifications for components included in the formulation		
1.3 Full taxonomic classification		
1.4 Method of identification enumeration and quantification		
1.5 Development code		
1.6 Source, name and address of formulator and address and location of processing plants		
1.7 Collection and culture reference number where culture is deposited		
1.8 Methods of production and quality control		
1.9 Patent status of production process		
a) Is the product under patent?		
b) Who is patent holder?		
c) When was product patented?		
d) Expiry date of patent		

2. PHYSICAL AND CHEMICAL PROPERTIES OF FORMULATED PRODUCT

	Annex No. in dossier if study included	Official use only
2.1 Physical state (solid, liquid etc)		
2.2 Colour		
2.3 Odour		
2.4 Effects of light, air, temperature, water on technical characteristics of the formulation		
2.5 Storage stability in proposed packaging		
2.6 Shelf life		
2.7 Compatibility with other pesticides		
2.8 Water content (humidity)		

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3. BIOLOGICAL PROPERTIES OF THE FORMULATED MACROBIAL AGENT

	Annex No. in dossier if study included	Official use only
3.1 History of the formulated product and its uses		
3.2 Description of the target organism(s) and mode of action of the macrobial agent		
3.3 Host specificity range and effects on species other than the target harmful organism		
3.4 Life cycle stage at which the macrobial agent is applied		
3.5 Invasiveness, dispersal and colonization ability		
3.6 Effect of environmental parameters (UV, temperature, soil pH, humidity, etc.) on stability and survival of macrobial agents		
3.7 Relationships to known plant, animal or human parasites		
3 8 Genetic stability of the formulated macrobial agent		
3.9 Information on the production of metabolites (relevant to entomopathogenic nematodes)		

4. FURTHER INFORMATION ON THE FORMULATED MACROBIAL AGENT

	Annex No. in dossier if study included	Official use only
4.1 Biological function (control of insects, mites, ticks, nematodes, weeds, molluscs, etc.)		
4.2 Information on the occurrence or potential development of resistance of the target organism(s)		
4.3 Methods to prevent loss of predation or parasitic properties of the seed stock of the macro-organism		
4.4 Recommended methods and precautions concerning handling, storage, or transport		
4.5 Procedures for destruction		
4.6 Measures in case of an accident		

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5. BIOSAFETY

Hazard data may be waived where there is sufficient evidence that the product is safe. This would be based on results of medical surveillance, published data, as well as actual studies on the product.

	Annex No. in dossier if study included	Official use only
5.1 Medical surveillance data for manufacturing plant and agricultural workers (such as occurrence of hypersensitivity/allergies)		
5.2 Discussion of the effects of repeated human exposure		
5.3 Other studies		

6. ENVIRONMENTAL SAFETY

Waivers may be granted on presentation of evidence that exposure to the particular non-target organism will not occur, or where effects of exposure are already documented. Selection of test non-target organisms will be on a case-by-case basis and according to mode of action and ecological relevance.

	Annex No. in dossier if study included	Official use only
6.1 Aquatic organisms (2 species) Fish Daphnia		
6.2 Aquatic invertebrate		
6.3 Bees		
6.4 Representative natural enemies		
6.5 Representative non-target plant		

7. BEHAVIOUR IN ENVIRONMENT

	Annex No. in dossier if study included	Official use only
7.1 Persistence of active agent (days)		
7.2 Mobility of active agent		

8. INTENDED USES

	Annex No. in dossier if study included	Official use only
8.1 Function (control of insects, mites, ticks, nematodes, weed, molluscs, etc)		
8.2 Target pest(s)		
8.3 Area of use		
8.4 Application rate (appropriate units)		
8.5 Method of application		

	Annex No. in dossier if study included	Official use only
8.6 Recommended number and timing of applications		
8.7 Stage of treatment of host crop		
8.8 Directions for use		
8.9 Pre-harvest interval		
8.10 Contraindications		
8.11 Efficacy data (guidelines provided separately)		

9. MINIMUM LABEL REQUIREMENTS

Specify the warnings, use restrictions and safety precautions which must be present on the label in all countries. The proposed label must be included in the dossier, should contain the specified warnings, use restrictions and safety precautions as well as meet PCPB label requirements. PCPB label requirements will be provided separately.

10. EVIDENCE OF REGISTRATION IN OTHER COUNTRIES

11. OTHER SPECIFIC REQUIREMENTS

	Annex No. in dossier if study included	Official use only
11.1 Medical surveillance, on manufacturing plant personnel		
11.2 Health records of occupationally exposed personnel – industry, agriculture, forestry, fisheries		

12. PROPOSED PACKAGING

	Annex No. in dossier if study included	Official use only
12.1 Type of packaging in which the product is imported		
12.2 Type of packaging for distribution in Kenya		
12.3 Packaging material		
12.4 Sizes of individual packaging		

13. PROCEDURES OF DESTRUCTION AND DECONTAMINATION

	Annex No. in dossier if study included	Official use only
13.1 Controlled incineration		
13.2 Procedures of cleaning application equipment (nematodes)		
13.3 Recommended methods and precautions concerning handling, storage, display or transport		

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GUIDELINE: DOSSIER FOR A MACROBIAL PEST CONTROL AGENT

The dossier accompanying this form should provide details of the information requested. Methods used in the identification of the agent (based on international standards on the nomenclature for arthropods), detailed biological properties and efficacy studies etc. must be given. Numbering used in the dossier must correspond with that used in the application form.

1. IDENTITY OF ACTIVE AGENT (TECHNICAL GRADE)

REQUIREMENTS	REMARKS
1.1 Common name	Indicate where applicable
1.2 Full taxonomic name including isolate, strain or subspp. (where appropriate)	Full scientific name including any relevant information
1.3 Full taxonomic classification	Indicate full systemic classification including any relevant information
1.4 Methods of identification	Indicate procedure used to identify the active agent: morphology, histology, molecular biology, etc.
1.5 Development code	Specify source/developer
1.6 Source, name and address of developer and address and location of processing plants	Indicate company and country of origin. Name, address, location of processing plant
1.7 Methods of production and quality control	Developer to outline how the agent is isolated, purified, bulked, and maintained. Quality assurance should include methods of counting the number of macrobials per unit volume/weight
1.8 Collection and culture reference number where culture is deposited.	Agent is to be deposited in a recognized culture collection institute (e.g. National Museums of Kenya), the name of the collection and the culture reference number is to be given
1.9 Patent status	Give status as indicated below:
a) Is the production process of agent under patent?	
b) Who is the patent holder?	
c) When was the process patented?	
d) Expiry date of patent	

2. BIOLOGICAL PROPERTIES OF THE MACROBIAL AGENT

REQUIREMENTS	REMARKS
2.1 History of the macrobial agent, its uses, natural occurrence and geographical distribution	The geographical region and the place in the ecosystem (e.g. host plant, host animal, or soil from which the macro-organism was isolated) must be stated. The natural occurrence of the macro-organism in the relevant environment shall be given if possible to strain level. Indicate whether the micro-organism has been GRAS (generally regarded as safe) listed
2.2 Description of the target organism(s) and mode of action	The principal mode of action should be indicated and if the macro-organism produces a toxin with a residual effect on the target organism. In that case, the mode of action of this toxin should be described. If relevant, information on the site of infection and mode of entry into the target organism and its susceptible stages should be given. The results of any experimental studies must be reported.

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REQUIREMENTS	REMARKS
	Transmissibility (possibility of spread of the macro-organism from one target population to another, but also from one target species to another (target) species after release under the proposed condition of use) shall be indicated.
2.3 Host specificity range and effects on species other than the target harmful organism	Any available information on the effects of macrobial on non-target organisms within the area of spread shall be given. The occurrence of non-target organisms closely related to the target species in the area of release shall be indicated.
2.4 Developmental stages/life cycle of the macrobial agent	Information on the life cycle, symbiosis, parasitism, competition, predation, host organisms, etc. of the macrobial agent must be presented. The generation time and the type of reproduction of the macro-organism must be stated. Information on the occurrence of resting stages and their survival time, their virulence and infection potential must be provided.
2.5 Invasiveness, dispersal and colonization ability	Information is to be provided on the behaviour of the micro-organism under typical environmental conditions of use.
2.6 Effect of environmental parameters (UV, temperature, soil pH, humidity, etc.) on stability and survival on stability and survival of macrobial agent	The persistence of the macro-organism under the typical environmental conditions of use must be indicated. Any particular sensitivity to certain components of the environment (e.g. UV light, soil, water) must be stated. The environmental requirements (temperature range, pH, humidity, nutrition requirements, etc.) for survival, reproduction, and effectiveness of the macro-organism must be stated.
2.7 Relationships to known plant or animal or human pests or vectors of disease	The possible existence of one or more species of the genus of the agent known to be pests or vectors of diseases of humans, animals, crops or other non-target species shall be indicated. It shall be stated whether it is possible, and by which means, to clearly distinguish the active macro-organism from the pest or vectors of disease
2.8 Genetic stability of the macrobial agent and the target crop	Where appropriate, information on genetic stability (e.g. mutation rate of traits related to the mode of action or uptake of exogenous genetic material) under the environmental conditions of proposed use must be provided. The ability of the macrobial agent to control pests on GM crops must be indicated.
2.9 Information on the production of metabolites (especially toxins) (relevant to entomopathogenic nematodes)	The conditions under which the macro-organism produces the metabolite(s) (especially toxin(s)) must be described.

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3. FURTHER INFORMATION ON THE MACROBIAL PEST CONTROL PRODUCT

REQUIREMENTS	REMARKS
3.1 Biological function (control of insects, mites, nematodes, weed, molluscs, etc.)	The biological function must be specified
3.2 Information on the occurrence or possible occurrence of the development of resistance of the target organism(s) and resistance management strategy	Available information on the possible occurrence of the development of resistance or cross-resistance of the target organism(s) must be provided. Where possible, appropriate management strategies should be described
3.3 Methods to prevent loss of predation properties or parasitism of seed stock of the macro-organism	Methods to prevent loss of activity of starting cultures are to be provided. In addition, any method, if available, that could prevent the macro-organism from losing its effects on the target species must be described, particularly on macrobial agents produced on artificial diets
3.4 Recommended methods and precautions concerning handling, storage, and transport	Indicate any specific precautions
3.5 Procedures for destruction	Methods to dispose safely of the macrobial agent that are no longer needed should be provided.
3.6 Measures in case of an accident	Information on procedures for rendering the macro-organism harmless in the environment (e.g. water or soil) in case of an accident must be provided

4. BIOSAFETY

Include an executive summary discussing **ALL ISSUES** named under Section 3 of the form or provide the individual summaries from each study relating to issues mentioned under Section 3 of the form. Information on the methods of testing used must be provided.

REQUIREMENTS	REMARKS
4.1 Medical surveillance data for manufacturing plant and agricultural workers (such as occurrence of hypersensitivity/allergies)	Available reports of occupational health surveillance programmes, must be submitted. These reports shall, where available, include data from persons exposed in manufacturing plants or after application of the macro-organism (e.g. in efficacy trials)
4.2 Discussion of the effects of repeated human exposure	Provide any available information
4.3 Other studies	Provide any available information

5. ENVIRONMENTAL SAFETY

Provide either an executive summary or individual summaries of studies on the behaviour in the environment providing information requested in the form.

REQUIREMENTS	REMARKS
5.1 Aquatic organisms (2 species)	Provide any relevant information
5.2 Aquatic invertebrates	Specify and provide details on other organisms according to the information requested on the form.
5.3 Bees	
5.4 Representative natural enemies	
5.5 Representative non-target plant	Provide any relevant information

6. BEHAVIOUR IN ENVIRONMENT

REQUIREMENTS	REMARKS
6.1 Persistence of active agent (days)	Provide any relevant information with special reference to rates of re-seeding
6.2 Mobility of active agent	Indicate the rate of spread of the macrobial agent in the environment after application

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GUIDELINE: DOSSIER FOR A FORMULATED MACROBIAL PEST CONTROL PRODUCT

The dossier accompanying this form should provide details of the information requested. Methods used in the identification of the agent (based on international standards on the nomenclature for arthropods), detailed biological properties and efficacy studies etc. must be given. Numbering used in the dossier must correspond with that used in the application form.

1. IDENTITY (FORMULATED)

REQUIREMENTS	REMARKS
1.1 Formulation type and code	Provide information on the formulation type
1.2. Source and specifications for components included in the formulation	Give geographical origin, company, reference laboratory, etc.
1.3 Full taxonomic classification	Indicate full systemic classification including any relevant information
1.4 Methods of identification, enumeration and quantification	Morphology, histology, molecular biology, numbers of infective material per unit volume/weight, etc.
1.5 Development code	Specify source/developer
1.6 Source, name and address of formulator and address and location of processing plants	Indicate company and country of origin. Name, address, location of processing plant
1.7 Collection and culture reference number where culture is deposited	Agent is to be deposited in a recognized culture collection institute (e.g. National Museums of Kenya), the name of the collection and the culture reference number is to be given.
1.8 Methods of production and quality control	Developer to outline how the agent is isolated, purified, bulked, and maintained. Quality assurance should include methods of counting the number of macrobials per unit volume/weight.
1.9 Patent status	Provide information as indicated below
a) Is the production process of agent under patent?	
b) Who is the patent holder?	
c) When was the process patented?	
d) Expiry date of patent	

2. PHYSICAL AND CHEMICAL PROPERTIES OF THE FORMULATED PRODUCT

REQUIREMENTS	REMARKS
2.1 Physical state (solid, liquid etc)	
2.2 Colour	
2.3 Odour	
2.4 Effects of light, air, temperature, water on technical characteristics of the formulation	Provide information with evidence
2.5 Storage stability in proposed packaging	Specify conditions for storage with evidence
2.6 Shelf life	Indicate production date and expiration date. Provide data to support shelf life.
2.7 Compatibility with other pesticides	Indicate type of pest control products with which the product is or is not compatible. Give evidence
2.8 Water content (humidity)	Indicate level of moisture/humidity under which the product remains viable

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3. BIOLOGICAL PROPERTIES OF THE FORMULATED MACROBIAL AGENT

REQUIREMENTS	REMARKS
3.1 History of the formulated product and its uses	The geographical region and the place in the ecosystem (e.g. host plant, host animal, or soil from which the macro-organism was isolated) must be stated. The natural occurrence of the macro-organism in the relevant environment shall be given if possible to strain level. Indicate whether the micro-organism has been GRAS (generally regarded as safe) listed.
3.2 Description of the target organism(s) and mode of action of the macrobial agent	The principal mode of action should be indicated and if the macro-organism produces a toxin with a residual effect on the target organism, then the mode of action of this toxin should be described. If relevant (e.g. nematodes), information on the site of infection and mode of entry into the target organism and its susceptible stages should be given. The results of any experimental studies must be reported. Transmissibility (possibility of spread of the macro-organism from one target population to another, but also from one target species to another after release under the proposed condition of use) shall be indicated.
3.3 Host specificity range and effects on species other than the target harmful organism	Any available information on the effects of macrobial on non-target organisms within the area of spread shall be given. The occurrence of non-target organisms closely related to the target species in the area of release shall also be indicated.
3.4 Life cycle stage at which the macrobial agent is applied	Information on the life cycle stage of the macrobial agent for field release must be presented. The life cycle stage at which the target organism is susceptible to the macrobial attack must also be given.
3.5 Invasiveness, dispersal and colonization ability	Information on the behaviour of the macro-organism under typical environmental conditions of use must be provided.
3.6 Effect of environmental parameters (UV, temperature, soil pH, humidity, etc.) on stability and survival on stability and survival of macrobial agent	The persistence of the macro-organism under the typical environmental conditions of use must be indicated. Any particular sensitivity to certain components of the environment (e.g. UV light, soil, water) must be stated. The environmental requirements (temperature range, pH, humidity, nutrition requirements, etc.) for survival, reproduction, and effectiveness of the macro-organism must also be stated.
3.7 Relationships to known plant or animal or human pests or vectors of disease	The possible existence of one or more species of the genus of the agent known to be pests or vectors of diseases of humans, animals, crops or other non-target species shall be indicated. It shall be stated whether it is possible, and by which means, to clearly distinguish the active macro-organism from the pest or vectors of disease
3.8 Genetic stability of the formulated macrobial agent and the target crop	Where appropriate, information on genetic stability (e.g. mutation rate of traits related to the mode of action or uptake of exogenous genetic material) under the environmental conditions of proposed use must be provided. The ability of the macrobial agent to control pests on GM crops must be indicated...

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REQUIREMENTS	REMARKS
3.9 Information on the production of metabolites (especially toxins) (relevant to entomopathogenic nematodes)	The conditions under which the macro-organism produces the metabolite(s) (especially toxin(s)) must be described.

4. FURTHER INFORMATION ON THE FORMULATED MACROBIAL AGENT

REQUIREMENTS	REMARKS
4.1 Biological function (control of insects, mites, ticks, nematodes, weeds, molluscs, etc.)	The biological function must be specified
4.2 Information on the occurrence or possible occurrence of the development of resistance of the target organism(s)	Available information on the possible occurrence of the development of resistance or cross-resistance of the target organism(s) must be provided. Where possible, appropriate management strategies should be described
4.3 Methods to prevent loss of predation properties or parasitism of seed stock of the macro-organism	Methods to prevent loss of activity of starting cultures are to be provided. In addition, any method, if available, that could prevent the macro-organism from losing its effects on the target species must be described, particularly on macrobial agents produced on artificial diets
4.4 Recommended methods and precautions concerning handling, storage, and transport	Indicate any specific precautions
4.5 Procedures for destruction	Methods to dispose safely of the macrobial agent which are no longer needed should be provided
4.6 Measures in case of an accident	Information on procedures for rendering the macro-organism harmless in the environment in case of an accident must be provided

5. BIOSAFETY

Include an executive summary discussing **ALL ISSUES** named under Section 3 of the form or provide the individual summaries from each study relating to issues mentioned under Section 3 of the form. Information on the methods of testing used must be provided.

REQUIREMENTS	REMARKS
5.1 Medical surveillance data for manufacturing plant and agricultural workers (such as occurrence of hypersensitivity/allergies)	Available reports of occupational health surveillance programmes, must be submitted. These reports shall, where available, include data from persons exposed in manufacturing plants or after application of the macro-organism (e.g. in efficacy trials)
5.2 Discussion of the effects of repeated human exposure	Provide any available information
5.3 Other studies	Provide any available information

6. ENVIRONMENTAL SAFETY

Provide either an executive summary or individual summaries of studies on the behaviour in the environment providing information requested in the form.

REQUIREMENTS	REMARKS
6.1 Aquatic organisms (2 species) Fish Daphnia	Provide any relevant information
6.2 Aquatic invertebrates	Specify and provide details on other organisms according to the information requested on the form.
6.3 Bees	
6.4 Representative natural enemies	
6.5 Representative non-target plant	Provide any relevant information

7. BEHAVIOUR IN ENVIRONMENT

REQUIREMENTS	REMARKS
7.1 Persistence of formulation (days)	Provide any relevant information with special reference to rates of re-seeding
7.2 Mobility of active agent	Indicate the rate of spread of the macrobial agent in the environment after application

8. INTENDED USES

REQUIREMENTS	REMARKS
8.1 Function (control of insects, fungi, mites, ticks, bacteria, viruses, nematodes, weed, molluscs, etc.)	State whether it will be used as a fungicide, insecticide etc.
8.2 Target pest(s)	Name of target pest(s)
8.3 Area of use	Specify (crops, livestock, public health, or environment)
8.4 Application rate (appropriate units)	Specify rate
8.5 Method of application	Specify
8.6 Recommended number and timing of applications	Specify timing and frequency
8.7 Stage of treatment of host crop	Specify growth stage of host crop
8.8 Directions for use	Specify on label and/or leaflet
8.9 Pre-harvest interval	Specify on label and/or leaflet
8.10 Contraindications	Specify on label and/or leaflet
8.11 Efficacy data (guidelines provided separately)	Provide efficacy data from country of origin and other countries of similar climatic conditions. In addition efficacy data from local trials must be provided

9. MINIMUM LABEL REQUIREMENTS

Specify the warnings, use restrictions and safety precautions which must be present on the label in all countries. The proposed label must be included in the dossier, should contain the specified warnings, use restrictions and safety precautions as well as meet PCPB label requirements. PCPB label requirements will be provided separately.

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10. EVIDENCE OF REGISTRATION IN OTHER COUNTRIES

11. OTHER SPECIFIC REQUIREMENTS

REQUIREMENTS	REMARKS
11.1 Medical surveillance, on manufacturing plant personnel	Provide details
11.2 Health records of occupationally exposed personnel – industry, agriculture, forestry, fisheries	Provide details

12. PROPOSED PACKAGING

REQUIREMENTS	REMARKS
12.1 Type of packaging in which the product is imported	Provide details
12.2 Type of packaging for distribution in Kenya	Provide details
12.3 Packaging material	Provide details
12.4 Sizes of individual packaging	Provide details

13. PROCEDURES OF DESTRUCTION AND DECONTAMINATION

REQUIREMENTS	REMARKS
13.1 Controlled incineration	Provide details
13.2 Procedures of cleaning application equipment	Provide details
13.3 Recommended methods and precautions concerning handling, storage, display or transport	Provide details

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ACRONYMS and ABREVIATIONS

μg	microgram
a.a.	active agent
BCF	bio concentration factor
cfu	colony forming units
CIPAC	Collaborative International Pesticides Analytical Council
EC	emulsifiable concentrate
EC_{50}	median effective concentrate
FAO	Food and Agriculture Organization of the United Nations
g/kg	grams per kilogram
g/l	grams per litre
GMOs	genetically modified organism
GRAS	generally regarded as safe
ISO	International Standards Organization
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspectorate Service
KSTCIE	Kenya Standing Technical Committee on Imports and Exports
LC_{50}	median lethal concentrate
LD_{50}	median lethal dose
LMOs	living modified organisms
mg/l	milligrams per litre
MSDS	material safety data sheet
NARL	National Agricultural Research Laboratory
NOEL	non observable effective level
^{o}C	degrees Celsius/centigrade
OECD	Organization for Economic Co-operation and Development
PCPB	Pest Control Products Board
PHI	pre-harvest interval
SEARCH	Southern and Eastern African Regulatory Committee on Harmonization of Pesticide Registration
WHO	World Health Organization
WP	wettable powder

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Annex 3 Application for the Registration of a Biochemical Pest Control Product

FORM A2.3

PEST CONTROL PRODUCTS ACT, CAP 346, 1982
KENYA

APPLICATION FOR THE REGISTRATION OF A BIOCHEMICAL PEST CONTROL PRODUCT

INTRODUCTION

1. These guidelines are for any proposed use of the chemical products (growth regulators, pheromones, botanical products, etc.) of naturally occurring organisms (bacteria, protozoa, fungi, viruses, plants, animals, etc.) for the control of invertebrate pests and pathogens of crops and livestock, the control of weeds, public health and environment. The use of biochemical agents for the control of vertebrate pests is not contemplated.
2. Information in support of a request for registration, both published and unpublished should be supplied in the form of a summary data sheet laid out according to the format given in Form A2.

Information for Applicants

1. The application form must be completed by a person duly authorized by the applicant/company.
2. The application must be submitted in triplicate to: The Secretary, Pest Control Products Board (PCPB) P.O. Box 13794, Nairobi
   E-mail address pcpboard@todays.co.ke or pcpboard@nbnet.co.ke
   Tel 254-2-4446115; Fax 254-2-4449072.
3. Every application must be accompanied by:
   a. registration fee as prescribed
   b. 3 copies of the draft label as per PCPB requirements.
4. The applicant shall be required to submit:
   a. a sample of the pest control product
   b. a sample of the technical grade of its active ingredient
   c. a sample of the laboratory standard of its active ingredient
   d. any other sample as may be required by PCPB.
5. List I and II are supplied as check lists and an index to ensure that the applicant has provided all relevant data.
6. The application must be accompanied by a technical dossier as per PCPB data requirements i.e. Lists I and II.
7. An applicant who is not a resident in Kenya must appoint an agent permanently resident in Kenya.

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PURPOSE OF APPLICATION (tick as appropriate)

a. Biochemical pesticides containing a new active ingredient	☐
b. Biochemical pesticides where source of active and/or formulation is not identical to that of a registered product	☐
c. Registration transfer	☐
d. Amendments to existing registration	☐
e. Other (explain)	
Will the product be marketed under own label Yes ☐ No ☐ If No, specify	

1. APPLICANT

1.1 Identification		
1.2 Name of applicant/corporate name of company		
1.3 Reg No.		
1.4 Name of registration holder		
1.5 Name of local agent in country (if different from registration holder)		
1.6 Status (importer/formulator/ distributor) etc.		
1.7 Physical address		
1.8 Postal address		
1.9 Telephone (and area code)		
Fax (and area code)		
Email		

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2. PRODUCT

2.1 Identity	
2.2 Concentration of a.i.	
2.3 Designation (description of product)	Trade name:
	Trade mark:
	Trade mark holder:
	Internal code:
2.4 Function of product (e.g. insecticide, herbicide etc.)	
2.5 Intended use (veterinary, public health, industrial, agriculture, forestry, etc.)	
2.6 Target pest(s) and host(s)	
2.7 Method, dosage rates and frequency of application	
2.8 Type of formulation (e.g. EC*, WP, etc.)	
2.9 Is the product registered in country of: a) origin b) manufacture c) formulation	Yes ☐ No ☐ If no, specify ..... Yes ☐ No ☐ If no, specify ..... Yes ☐ No ☐ If no, specify .....
2.10 Registration in SEARCH country/ies (names)	
2.11 Registration in other country(ies), especially OECD countries (names)	
2.12 Customs Tariff Code (Brussels Tariff Nomenclature)	

3. COMPOSITION OF ACTIVE INGREDIENT(S) (Technical grade)

(Information on a.i may be attached in sealed envelope)

Active ingredient(s) (common name(s)	Manufacturer (name and address)	Minimum a.i.% purity	a.i. range %

* Acronyms and abbreviations can be found at the end this document (Annex 3)

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4. TOXICOLOGY OF ACTIVE INGREDIENTS (Technical grade)

	Acute oral (LD_{50} mg/kg)	Acute dermal (LD_{50} mg/kg)	Inhalation LC_{50} (mg/l/4 hour)
	Experimental	Experimental	Experimental
	Calculated	Calculated	Calculated

5. FORMULATION

5.1 Formulator (name):	Postal address:
5.2 Internal code:	Physical address:

5.3 Composition (Information on composition may be attached in sealed envelope)

Ingredients and function	Units	Units	Range

6. TOXICOLOGY (formulated product)

6.1 Rat:	Acute oral (LD_{50} mg/kg)	Acute dermal (LD_{50} g/kg)	Inhalation LC_{50} (mg/l/4 hour)
	Experimental	Experimental	Experimental
	Calculated	Calculated	Calculated

6.2 Rabbit:	Skin irritation	Eye irritation
None		
Mild		
Moderate		
Severe		

6.3 Skin sensitization in guinea pig (tick) — None ☐ Mild ☐ Moderate ☐ Severe ☐

6.4 WHO classification	Ia	Ib	II	III	Others

6.5 Summary of other mammalian toxicological information may be required

6.6 Summary of environmental effects

6.6.1 Toxicity to bees	
6.6.2 Toxicity to fish and other aquatic organisms	
6.6.3 Toxicity to birds	
6.6.4 Toxicity to earthworms and soil micro-organisms	

6.6.5 Toxicity to other non-target organisms may be required	
6.6.6 Persistence in environment	
6.6.7 Other effects: specify	

7. PACKAGING

7.1 Packaging material/container	
7.2 Pack size(s)	
7.3 Disposal of empty container(s)	

8. OTHER SPECIFIC REQUIREMENTS

8.1 Operator exposure	
8.2 Dermal absorption	
8.3 Likely operator exposure under field conditions	
8.4 Available toxicological data relating to other ingredients in formulation (non-active additives in formulation)	

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9. DECLARATION

<table>
<tr><td colspan="2">For and on behalf of ……..……., I hereby certify that the above mentioned information and data provided in support of this application are to the best of my knowledge true, correct and complete.</td></tr>
<tr><td>……..
Name in full (printed)</td><td>……
Signature</td></tr>
<tr><td>……
Official Title</td><td>……
Date</td></tr>
<tr><td>Official Stamp
of Applicant/Company</td><td>FOR OFFICIAL USE

Remarks
.....
.....
.....
.....
Signed: Date:.....</td></tr>
</table>

NOTE: The format of this application form is recognized by all SEARCH countries.

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FORM A2, LIST I

ACTIVE INGREDIENT: DOSSIER INDEX FOR A BIOCHEMICAL PEST CONTROL PRODUCT

The dossier accompanying the application must provide full details (as applicable) of the information requested in this list. i.e., details of the methods used and results of toxicological and ecotoxicological studies, methods of analysis, etc. Numbering used in the dossier must correspond to that used in the application form. If the product contains more than one active ingredient/agent, compile a separate dossier for each active ingredient.

1. DESIGNATION/IDENTITY OF ACTIVE INGREDIENT (Technical grade)

	Annex No. in dossier if study included	Official use only
1.1 Common name (ISO)		
1.2 Chemical/scientific name		
1.3 Chemical group/classification		
1.4 Structural formula (if applicable)		
1.5 Empirical formula (if applicable)		
1.6 Manufacturer or development code		
1.7 Source, name and address of manufacturer and address and location of manufacturing plants		
1.8 Methods of manufacture (synthesis pathways)		
1.9 Composition of the natural product before formulation		
1.10 Patent status		
a) Is the a.i./agent under patent?		
b) Who is patent holder?		
c) When was the product patented?		
d) What is the expiry date		
1.11 Molecular mass (if applicable)		
1.12 CAS number (if applicable)		

2. PHYSICAL AND CHEMICAL PROPERTIES (Active ingredient – technical grade)

	Annex No. in dossier if study included	Official use only
2.1 Physical state (liquid, solid etc)		
2.2 Colour		
2.3 Odour		
2.4 Density at 20°C (if applicable)		
2.5 Vapour pressure at 20/25°C		
2.6 Volatility (if applicable)		
2.7 Hydrolysis DT_{50} ….. Days …… °C …… PH (if applicable)		
2.8 Photolysis		
2.9 Solubility in water ……..°C …….. PH (if applicable)		
2.10 Solubility in organic solvents		
2.11 n-octanol/water partition coefficient (if applicable)		
2.12 Boiling point °C (if applicable)		
2.13 Melting point °C (if applicable)		

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	Annex No. in dossier if study included	Official use only
2.14 Decomposition temperature °C		
2.15 Method of analysis, active agent and Impurities/contaminants		
2.16 Stability in water, hydrolysis rate, effect of light, identity of breakdown products may be required		
2.17 Stability in organic solvents used in formulation (if applicable)		
2.18 Stability in air; identity of breakdown products (if applicable)		
2.19 Thermal stability, identity of breakdown product		
2.20 Flammability (if applicable)		
2.21 Flash point (if applicable)		
2.22 Explosive properties (if applicable)		
2.23 Oxidizing properties (if applicable)		
2.24 Absorption spectra – UV/Visible, infra-red, IMR, MS (at least two)		
2.25 Reactivity towards container material		

3. TOXICOLOGY
(Active ingredient – technical grade)

	Annex No. in dossier if study included	Official use only
3.1 Acute oral LD_{50} mg/kg rat/rabbit		
3.2 Acute dermal LD_{50} mg/kg rat/rabbit		
3.3 Inhalation LC_{50} mg/l/4 hour (rat)		
3.4 Skin irritation (rabbit)		
3.5 Primary eye irritation (rabbit)		
3.6 Skin sensitization (guinea pig)		
3.7 Reproduction, infectivity, pathogenicity (specify species)		
3.8 Subchronic toxicity 90 day NOEL mg/kg/day (optional)		
3.9 Chronic toxicity NOEL mg/kg/day		
3.10 Carcinogenicity (life time) NOEL mg/kg/day (conditional for semiochemicals)		
3.11 Neurotoxicity NOEL mg/kg/day (conditional for semiochemicals)		
3.12 Teratogenicity NOEL mg/kg/day conditional for semiochemicals)		
3.13 Mutagenicity/genotoxicity (conditional for semiochemicals)		
3.14 Metabolism (rat)		
3.15 Hypersensitivity/allergies in human		
3.16 Other studies		

4. ECOTOXICOLOGY
(Active ingredient – technical grade)

		Annex No. in dossier if study included	Official use only
4.1 Birds* (2 species)	LD_{50} mg/kg NOEL Reproduction		
	LD_{50} mg/kg NOEL Reproduction		
4.2 Fish* (2 species)	LD_{50} mg/kg NOEL LD_{50} mg/kg		
	NOEL Reproduction BCF		
4.3 Daphnia*	LC_{50} mg/l NOEL		
4.4 Algae	LC_{50} mg/l NOEL		
4.5 Bees*	LD_{50} µg/bee NOEL		
4.6 Earthworms*	LC_{50} mg/kg		
4.7 Soil micro-organism (if applicable)			
4.8 Others (e.g. plants)			

* conditional requirement for semiochemicals

5. BEHAVIOUR IN ENVIRONMENT
(Active ingredient – technical grade)

	Annex No. in dossier if study included	Official use only
5.1 Behaviour, ways of degradation, degradation products in soil		
5.1.1 Major metabolites (viable and non-viable)		
5.1.2 DT_{50} (days)		
5.1.3 Mobility of a.i.		
5.1.4 Adsorption/desorption		
5.1.5 Mobility of metabolites		
5.2 Behaviour, ways of degradation, degradation products in water		
5.2.1 Major Metabolites (viable and non-viable)		
5.2.2 DT_{50} (days)		
5.2.3 Surface water		
5.2.4 Ground water		
5.3 Behaviour, ways of degradation, degradation products in air		

6. MODE OF ACTION

	Annex No. in dossier if study included	Official use only
6.1 Mode of action of biochemical		

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7. RESIDUES

	Annex No. in dossier if study included	Official use only
7.1 Major metabolites/agents (viable and non-viable		
7.2 Metabolism		
7.3 Behaviour of residues		
7.4 Adsorption/absorption		
7.5 MRL codex		
7.6 MRL country of origin		
7.7 PHI, proposed MRL and ADI		
7.8 Method of residue analysis		

8. OTHER SPECIFIC REQUIREMENTS

	Annex No. in dossier if study included	Official use only
8.1 Residue data from a GLP certified laboratory or as directed by the Secretary PCPB		
8.2 Proposed PHIs, withholding periods in case of post-harvest use		
8.3 Effects on taint, odour, taste or other quality aspects due to residues in or on fresh or processed products		
8.4 Effects on industrial processing and/or household preparation on the nature and magnitude of residues		
8.5 Residue data in succeeding or rotational crops where presence of residues might be expected		

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FORM A2, LIST II

FORMULATED PRODUCT: DOSSIER INDEX FOR A BIOCHEMICAL PEST CONTROL PRODUCT

The dossier accompanying the form should provide more details of the information requested in this list. Summaries of the methods and results used in toxicological and ecotoxicological studies, methods of analysis etc. must be provided. Numbering used in the dossier must correspond with that used in the application Form A2.3 LIST II.

1. PHYSICAL AND CHEMICAL PROPERTIES

	Annex No. in dossier if study included	Official use only
1.1 Source and specifications for components included in the formulation		
1.2 Physical state (solid, liquid etc.)		
1.3 Colour		
1.4 Odour		
1.5 Effects of light, air, temperature, water on technical characteristics of the formulation		
1.6 Storage stability in proposed packaging		
1 7 Shelf life		
1.8 Density/bulk density (where applicable)		
1.9 Bulk density		
1.10 Flammability		
1.11 Flash point		
1.12 Explosivity		
1.13 Compatibility with other pesticides		
1.14 pH		
1.15 pH of 1% aqueous dilution		
1.16 Oxidizing properties		
1.17 Corrosiveness		
1.18 Water content		
1.19 Wettability		
1.20 Solubility in water		
1.21 Solubility in organic solvents		
1.22 Partition coefficient in n-octanol		
1.23 Persistent foaming		
1.24 Particle size		
1.25 Wet sieve test		
1.26 Dry sieve test		
1.27 Suspensibility/emulsifiability		
1.28 Emulsion stability		
1.29 Volatility		
1.30 Viscosity		
1.31 Other properties		
1.32 Methods of analysis		

Note: This information is required where applicable

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2. TOXICOLOGY

	Annex No. in dossier if study included	Official use only
2.1 Acute oral LD50 mg/kg (rat/rabbit)		
2.2 Acute dermal LD50 mg/kg		
2.3 Inhalation LC50 mg/l/4 hour		
2.4 Skin irritation (rabbit)		
2.5 Primary eye irritation		
2.6 Skin sensitisation in guinea pig		
2.7 WHO classification		
2.8 Other studies (if applicable)		

3. EMERGENCY PROCEDURES IN CASE OF ACCIDENTAL EXPOSURE OR POISONING

	Annex No. in dossier if study included	Official use only
3.1 Symptoms of human poisoning		
3.2 Mode of action in man		
3.3 First aid treatment		
3.4 Skin contact		
3.5 Eye contact		
3.6 Inhalation		
3.7 Ingestion		
3.8 Antidote		
3.9 Note to physician		

4. EMERGENCY PROCEDURES IN CASE OF FIRE/SPILLAGE

	Annex No. in dossier if study included	Official use only
4.1 Fire fighting measures		
4.2 Procedures in case of spillage		

5. USES/EFFICACY DATA (New label claims with this application)

	Annex No. in dossier if study included	Official use only
5.1 Crop/area of use		
5.2 Target organism		
5.3 Rate of application		
5.4 Stage of treatment		
5.5 Directions for use		
5.6 Residue data, PHI and ADI		
5.7 Phytotoxicity		
5.8 Contraindications		

6. MINIMUM LABEL REQUIREMENTS – See requirements (provided separately).

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7. OTHER SPECIFIC REQUIREMENTS

		Annex No. in dossier if study included	Official use only
7.1	Medium surveillance on manufacturing plant personnel		
7.2	Health records of occupationally exposed personnel – industry, agriculture, forestry, fisheries		
7.3	Proposed packaging:		
7.3.1	Type of packaging in which the product is imported		
7.3.2	Type of packaging for distribution in Kenya		
7.3.3	Packaging material		
7.3.4	Sizes of individual packaging		
7.4	Procedures of destruction and decontamination of pest control product and its packaging:		
7.4.1	Possibility of neutralization		
7.4.2	Controlled discharge		
7.4.3	Controlled incineration		
7.4.4	Water purification		
7.4.5	Procedures of cleaning application equipment		
7.4.6	Recommended methods and precautions concerning handling, storage, display or transport		

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GUIDELINE: DOSSIER FOR A BIOCHEMICAL PEST CONTROL ACTIVE INGREDIENT

The dossier accompanying this form should provide details of the information requested. Methods used (physical and chemical), details of the methods used in and results of toxicological and ecotoxicological studies, methods of analysis etc. have to be given. Numbering used in the dossier must correspond with that used in the application form.

1. IDENTITY OF ACTIVE INGREDIENT (Technical Grade)

REQUIREMENTS	REMARKS
1.1 Common name (ISO)	Indicate where applicable
1.2 Chemical/scientific name	State chemical name or full scientific name if applicable
1.3 Chemical group/classification	State chemical group/classification
1.4 Structural formula (if applicable)	Specify if applicable
1.5 Empirical formula (if applicable)	Specify if applicable
1.6 Manufacturer or development code	Specify source/manufacturer
1.7 Source, name and address of manufacturer and address and location of manufacturing plants	Source: Natural occurrence and geographical destination For botanicals specify the plant part, stage of growth etc. Name, address, location of manufacturing plant
1.8 Methods of manufacture (synthesis pathways)	Manufacturers to outline how the product is produced in bulk, quality assurance, for manufacturing process, assay methods, Isolation, culturing of microbial agents if derived from a live organism
1.9 Composition of natural product before formulation	Give the composition of the active ingredient, methods of identification and purity of active ingredient Evidence to show freedom from microbial contamination, nature and identity of any impurities should be provided
1.10 Patent status	Specify
a) Is the a.i. under patent?	
b) Who is patent holder?	
c) When was the product patented?	
d) Expiry date	
1.11 Molecular mass (if applicable)	
1.12 CAS number (if applicable)	

2. PHYSICAL AND CHEMICAL PROPERTIES (Active ingredient – technical grade)

REQUIREMENTS	REMARKS
2.1 Physical state	Powder, liquid or solid
2.2 Colour	Specify if applicable
2.3 Odour	
2.4 Density at 20°C	
2.5 Vapour pressure at 20/25°C	
2.6 Volatility	

REQUIREMENTS	REMARKS
2.7 Hydrolysis/persistence	Give the DT_{50} of the active ingredient, with mention of temperature and pH parameters employed during the determination, include retention of biological activity in storage and in the field
2.8 Photolysis	Give the DT_{50} of the active ingredient (in days)
2.9 Solubility in water	Where relevant indicate method/test used.
2.10 Solubility organic solvents	
2.11 n-octanol/water partition coefficient	
2.12 Boiling point ^{o}C	
2.13 Melting point ^{o}C	
2.14 Decomposition temperature ^{o}C	
2.15 Method of analysis and impurities	
2.16 Stability in water, hydrolysis rate, effect of light, identity of breakdown products	Provide information with evidence
2.17 Stability in organic solvents used in formulation	
2.18 Stability in air; identity of breakdown products	
2.19 Thermal stability, identity of breakdown product	
2.20 Flamability	
2.21 Flash point	
2.22 Explosive properties	
2.23 Oxidizing properties	
2.24 Absorption spectra – UV/Visible, infra-red, IMR, MS	
2.25 Reactivity towards container material	

Note: Provide information where applicable.

3. TOXICOLOGY
(Active ingredient – technical grade)

Include a copy of an executive summary discussing **ALL ISSUES** named under Section 3 of the form or provide copies of the individual summaries from each study relating to issues mentioned under Section 3 of the form. Information on the methods of testing used must be provided.

REQUIREMENTS	REMARKS
3.1 Acute oral LD_{50} mg/kg rat/rabbit	Provide evidence
3.2 Acute dermal LD50 mg/kg rat/rabbit	
3.3 Inhalation LC_{50} mg/l/4 hour (rat)	This should be provided for the technical grade for all kinds of biochemicals
3.4 Skin irritation (rabbit)	
3.5 Primary eye irritation	Hazards associated with single application or associated with inert ingredients in product formulation
3.6 Skin sensitization (guinea pig)	Provide relevant information
3.7 Reproduction, infectivity, pathogenicity (specify species)	Provide relevant information
3.8 Subchronic toxicity 90 day NOEL mg/kg/day	Provide relevant information
3.9 Chronic toxicity NOEL mg/kg/day	Provide relevant information

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REQUIREMENTS	REMARKS
3.10 Carcinogenicity (life time) NOEL mg/kg/day	Provide relevant information
3.11 Neurotoxicity NEOL mg/kg/day	
3.12 Teratogenicity NOEL mg/kg/day	
3.13 Mutagenicity/genotoxicity	
3.14 Metabolism (rat)	
3.15 Intra-peritoneal injection for infectivity (for fungal and protozoa agent)	
3.16 Hypersensitivity/allergies in human	
3.17 Other studies	

NB Botanical preparations should be free from mycotoxins. (An analytical proof is required.)
Allergenic potential of biopesticides should be investigated and provided.

Other studies

Provide further information relevant to the toxicity profile of the product e.g. toxicity of major metabolites, reaction or breakdown products of the pesticides formed in/or on treated plant/crop etc, which are likely to be consumed in cases where different from those identified in animal studies. Toxic effects on livestock, poultry, pets should be stated.

4. ECOTOXICOLOGY

Provide either an executive summary or individual summaries of studies on the behaviour in the environment providing information requested in the form.

REQUIREMENTS		REMARKS
4.1 Birds (2 species)	LD_{50} mg/kg	Provide details of at least one land and one water bird, LD_{50} in mg product/kg bird weight and the NOEL. Furthermore provide information on the effect on reproduction.
	NOEL	
	Reproduction	
	LD_{50}mg/kg	
	NOEL	
	Reproduction	
4.2 Fish (2 species)	LD_{50} mg/kg	Provide details on at least two species studied, LC_{50} (in mg of product/litre of water) and the NOEL. Furthermore provide information on the effect on reproduction. Indicate the bioconcentration factor (BCF) on the active ingredient in tissues.
	NOEL	
	Reproduction	
	BCF	
	LD_{50} mg/kg	
	NOEL	
	Reproduction	
	BCF	
4.3 Daphnia	LC_{50} mg/l	Specify and provide details on other organisms according to the information requested on the form.
	NOEL	
4.4 Algae	LC_{50} mg/l	
	NOEL	
4.5 Bees	LD_{50} µg/bee	
	NOEL	
4.6 Earthworms	LC_{50} mg/kg	
4.7 Soil micro-organisms		
4.8 Others e.g. plants		If the agent is closely related to a crop pathogen or a pathogen of a vertebrate, species, laboratory evidence of genetic stability using appropriate tests is required.

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5. BEHAVIOUR IN ENVIRONMENT (Active ingredient – technical grade)

Provide an executive summary or copies of summaries from each study relating to the issues highlighted in this application form.

REQUIREMENTS	REMARKS
5.1 Behaviour, spread, mobility, multiplication ways of degradation, degradation products in soil	**Indicate the degradation path of the active ingredient in the soil and the degradation products formed**
5.1.1 Major metabolites/viable residues	Specify the major metabolites/viable or non-viable residues in the soil and their behaviour
5.1.2 DT_{50} (days)	Specify the half-life of the a.i. in various types of soils (or persistence, retention of biological activity)
5.1.3 Mobility of the a.i.	Specify the degree of mobility of the active ingredient in the soil hence leaching potential and possibility for groundwater contamination If high, provide details on further studies i.e. lysimeter study.
5.1.4 Adsorption/desorption	Indicate the degree of adsorption of the active ingredient in the soil
5.5.5 Mobility of metabolites spread, mobility, multiplication	Indicate the degree of mobility of the metabolites/ viable/non-viable residues in the soil
5.2 Behaviour, ways of degradation, degradation products in water	**Describe ways and speed of degradation of the active ingredient/agent in water**
5.2.1 Major metabolites (viable/non-viable)	Specify the major break down products formed and their adsorption/desorption on sediments
5.2.2 DT_{50} (days)	Specify the half life of the active ingredient in water
5.2.3 Surface water	Describe ways and speed of degradation in surface and ground water
5.2.4 Ground water	
5.3 Behaviour, ways of degradation, degradation products in air	**Describe ways and speed of degradation in air and break down product formed (for fumigants and volatile products)** **Provide an executive summary of the studies conducted**

6. MODE OF ACTION

REQUIREMENTS	REMARKS
6.1 Mode of action of biochemical	Explain the mechanism by which the pest control agent acts on the target organism, degree of specificity

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7. RESIDUES

Provide either an executive summary or individual summaries of studies conducted concerning the issues listed.

REQUIREMENTS	REMARKS
7.1 Major metabolites/agent/ viable and non-viable residues	Provide either an executive summary or individual summaries of studies conducted concerning the issues listed: Specify the metabolites/residues State their toxicological effects Retention of microbial activity.
7.2 Metabolism	Describe the principle of metabolization of the active ingredient/agent in the plant and the degradation products formed.
7.3 Behaviour of residues	Indicate the action and the persistence of the metabolites/agent/viable and non-viable residues in the plants and animals.
7.4 Adsorption/absorption	Provide either an executive summary or individual summaries of studies conducted by a GLP certified laboratory or as directed by the Secretary PCPB.
7.5 MRL codex	**MRLs (if available)** When available state for each crop or vegetable product, the Maximum Residue Limit (MRL) recommended by the Codex Alimentarius Commission, two effective MRLs in two different countries and the MRL proposed in the country of application. If the proposed crop is to be exported, provide detailed information in the dossier on MRL levels or import tolerances in the countries exported to. Provide information on ADI. Provide information on method of residue analysis.
7.6 MRL country of origin	
7.7 PHI, proposed MRL and ADI	
7.8 Method of residue analysis	

Residue data have to be provided for bioproducts if they are found to have toxicological, infectivity and pathogenicity concerns to mammals.

8. OTHER SPECIFIC REQUIREMENTS

REQUIREMENTS	REMARKS
8.1 Residue data from a GLP certified laboratory or as directed by Secretary, PCPB	Provide an executive summary or copies of summaries from each study relating to the issues highlighted in the form
8.2 Proposed pre-harvest intervals, withholding periods in cases on post-harvest use	
8.3 Effects on taint, odour, taste or other quality aspects due to residues in or on fresh or processed products	
8.4 Effects of industrial processing and/or household preparation on the nature and magnitude of residues	
8.5 Residue data in succeeding rotational crops where presence of residues might be expected	

***** For bioproducts found to have allergenic effects, detailed studies (on their residues) have to be provided.

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GUIDELINE: DOSSIER FOR A FORMULATED BIOCHEMICAL PEST CONTROL PRODUCT

1. PHYSICAL AND CHEMICAL PROPERTIES OF THE FORMULATED PRODUCT

Clearly state method used to determine properties under the appropriate section of the dossier. CIPAC methods are recommended.

REQUIREMENTS	REMARKS
1.1 Source and specifications for components included in the formulation	Specify
1.2 Physical state	Specify (solid, liquid, etc.)
1.3 Colour	Specify
1.4 Odour	Specify
1.5 Effects of light, air, temperature, water on technical characteristics of the formulation	Provide information with evidence
1.6 Storage stability in proposed packaging	Indicate the stability of the preparation after storing at 54°C for 14 days. Other durations and/or other temperatures (e.g. 8 weeks at 40°C, 18 weeks at 30°C) if the preparation is thermo-sensitive
1.7 Shelf life	The shelf life of the product at room temperatures (30°C) is given in years if it is more than two years, and in months if it is less than two years; the appropriate temperature specifications must be given. Indicate how the shelf life was determined
1.8 Density (where applicable)	Indicate the density of the liquids
1.9 Bulk density	Indicate the density of solids after compression
1.10 Flammability	Specify if the product is flammable.
1.11 Flash point	To determine flammable hazards
l.12 Explosivity	Provide information
1.13 Compatibility with other pesticides	Indicate types of pest control products which the product is or is not compatible with. Give evidence
1.14 pH range	State the effect of pH on stability and effectiveness
1.15 pH of 1% aqueous dilution	Relevant to products to be diluted in water
1.16 Oxidizing properties	Indicate materials that can be damaged by oxidizing properties of the formulation
1.17 Corrosiveness	Specify effect on containers, equipment, skin etc. If any
1.18 Water content	Indicate the maximum water content when it has an influence on the quality
1.19 Wettability	The wettability has to be indicated for solid formulations used in dilution (wettable powders, powder soluble in water and granules soluble in water)
1.20 Solubility in water	Specify
1.21 Persistent foaming	State the extent foaming occurs for formulations diluted in water
1.22 Particle size	Specify
1.23 Wet sieve test	If applicable provide evidence
1.24 Dry sieve test	
1.25 Suspensibility/emulsifiability	Specify
1.26 Emulsion stability	Specify

REQUIREMENTS	REMARKS
1.27 Volatility	Specify
1.28 Viscosity	For formulations to be used at very low volume, it is necessary to know the viscosity
1.29 Other properties (where applicable)	FAO specifications etc.
1.30 Method of analysis	Specify

Other studies

Provide detailed studies on any other relevant toxicological or ecotoxicological studies conducted on the formulated product.

2. TOXICOLOGY

The dossier must contain a detailed Material Safety Data Sheet. Furthermore either an executive summary, discussing all aspects mentioned under Section 2, must be included, or the summaries from each individual toxicity study and field in the same order.

REQUIREMENTS	REMARKS
2.1 Acute oral LD_{50} mg/kg rat/rabbit	Provide evidence
2.2 Acute dermal LD50 mg/kg rat/rabbit	
2.3 Inhalation LC_{50} mg/l/4 hour (rat)	This should be provided for the technical grade for all kinds of biochemicals
2.4 Skin irritation (rabbit)	
2.5 Primary eye irritation	Hazards associated with single application or associated with inert ingredients in product formulation
2.6 Skin sensitization (guinea pig)	Provide relevant information
2.7 WHO classification	See table below
2.8 Other studies	Indicate any other studies

NB Botanical preparations should be free from mycotoxins. (An analytical proof is required.)
Allergenic potential of biopesticides should be investigated and provided.

The FAO/WHO class must be given as per the table hereunder.

WHO Classification Scheme

Class	LD_{50} for the rat (mg/kg body weight)			
	Solids	Liquids	Solids	Liquids
	Oral		Dermal	
Ia Extremely hazardous	5 or less	20 or less	10 or less	40 or less
Ib Highly hazardous	5–50	20–200	10–100	40-400
II Moderately hazardous	50–500	200–2000	100–1000	400–4000
III Slightly hazardous	Over 500	Over 2000	Over 1000	Over 4000
Others				

3. EMERGENCY MEASURES IN CASES OF ACCIDENTAL EXPOSURE OR POISONING

Self explanatory. List relevant information of the form and refer to particular section in Material Safety Data Sheet (MSDS) in Section 3 of the dossier.

4. EMERGENCY PROCEDURES IN CASE OF FIRE/SPILLAGE

Self explanatory. List relevant information of form and refer to particular section in MSDS in Section 2 of dossier.

5. USES/EFFICACY DATA (New label claims with this application)

REQUIREMENTS	REMARKS
5.1 Crop/area of use	The common name of the crop on which the product is aimed must be clearly specified When the product is not aimed at a crop, indicate the area of use, e.g. Premises and equipment of transportation, Premises of storage
5.2 Target organism	Target organisms must be identified by common and scientific name Specify the mode of action of the product on its target, and indicate if the active ingredient is translocated inside the organism
5.3 Rate	The rate of application of the product must be indicated on the basis of area treated or volume used e.g. l/ha, g/ha, etc.
5.4 Stage of treatment	Specify the stage of the crop and target organism at which application must be made and/or the minimum interval between the last application and harvest
5.5 Directions for use	Indicate the recommended directions for use
5.6 Residue data, PHI and ADI	Indicate restrictions for MRL and ADI
5.7 Phytotoxicity	Indicate restrictions
5.8 Contraindications	Indicate restrictions i.e. follow-up crops, adjacent crops etc. and particular specifications, as well as possible incompatibilities of the formulation with other products

NB Efficacy data from country of origin should be attached.

6. MINIMUM LABEL REQUIREMENTS

Specify the warnings, use restrictions and safety precautions which must be present on the label in all countries. The proposed label must be included in the dossier, should contain the specified warnings, use restrictions and safety precautions as well as meet PCPB label requirements.
PCPB label requirements will be provided separately.

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7. OTHER SPECIFIC REQUIREMENTS

REQUIREMENTS	REMARKS
7.1 Medium surveillance, on manufacturing plant personnel	Provide details
7.2 Health records of occupationally exposed personnel – industry, agriculture, forestry, fisheries	Provide details
7.3 Proposed packaging:	Provide details
7.3.1 Type of packaging in which the product is imported	
7.3.2 Type of packaging for distribution in Kenya	
7.3.3 Packaging material	
7.3.4 Sizes of individual packaging	
7.4 Procedures of destruction and decontamination of pest control product and its packaging	Provide details
7.4.1 Possibility of neutralization	
7.4.2 Controlled discharge	
7.4.3 Controlled incineration	
7.4.4 Water purification	
7.4.5 Procedures of cleaning application equipment	
7.4.6 Recommended methods and precautions concerning handling, storage, display or transport	

ACRONYMS and ABREVIATIONS

μg	microgram
a.i.	active ingredient
ADI	acceptable daily intake
BCF	bio concentration factor
CAS	chemical abstracts system
cfu	cell forming units
CIPAC	Collaborative International Pesticides Analytical Council
CLI	Crop Life International
DT_{50}	Time it takes for 50% of the parent compound to disappear from soild or water by transformation (half life).
EC	emulsifiable concentrate
EC_{50}	median effective concentrate
FAO	Food and Agriculture Organization of the United Nations
g/kg	grams per kilogram
g/l	grams per litre
GCPF	Global Crop Protection Federation
IMR	infrared magnetic resonance
ISO	International Standards Organization
IUPAC	International Union of Pure and Analytical Chemists
LC_{50}	median lethal concentrate
LD_{50}	median lethal dose
mg/l	milligrams per litre
MRL	maximum residue limit
MS	mass spectroscoscopy
MSDS	material safety data sheet
NOEL	non observable effective level
OB	occlusion body
^{o}C	degrees centigrade
PCPB	Pest Control Products Board
PHI	pre-harvest interval
SEARCH	Southern and Eastern African Regulatory Committee on Harmonization of Pesticide Registration
WHO	World Health Organization
WP	wettable powder

Over the last 40 years, Kenyan researchers have been at the forefront of research into the identification and application of biopesticides. However, these developments have not been accompanied by the legislative structure to ensure the sustainable development and commercial usage of biopesticides in Kenya. In recognizing this legislative void, the Kenya Agricultural Research Institute (KARI), in collaboration with the Pest Control Products Board (PCPB) and the Department for International Development (DFID) Crop Protection Programme, hosted this workshop at Nakuru, Kenya.

The 17 papers in these proceedings, presented to a gathering of over 50, are arranged in four sessions: demand from the horticultural industry, contribution of research in Africa, registration in Africa and registration in other countries. Major issues concerning biopesticide registration were formulated as draft application documents for the registration of microbial, macrobial and biochemical pest control products – the main product of this three-day workshop. These have now been finalized for legislation and are presented as annexes to the proceedings.

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