CROP POST HARVEST PROGRAMME

Small-Scale Farmer Utilisation of Diatomaceous Earths During Storage

R8179 (ZB0299)

PROJECT FINAL REPORT

11 June 2002 – 31 January 2005

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Acronyms and Abbreviations

AETS	Dept. of Agricultural Engineering and Technical Services, Zw
AREX	Dept. of Agricultural Research and Extension Services, Zw
ASD	Actellic Super dust
ASDP	Agricultural Sector Development Programme, Tz
CBO	Community-based Organisations
CPHP	Crop Post Harvest Programme
DEs	Diatomaceous earths
DFID	Department for International Development, UK
DRT	Department of Research and Training, Tz
DPPO	District Plant Protection Officer, Tz
FMT	Farmer Managed Trial
GMB	Grain Marketing Board, Zw
HH	Household
HL	Horizontal learning
IAE	Institute of Agricultural Engineering, Zw
IPM	Integrated Pest Management
KMTC	Kulima Mbobumi Training Centre, Binga District, Zw
LA	Learning Alliances
LGB	Larger Grain Borer, *Prostephanus truncatus*
MAFS	Ministry of Agriculture and Food Security, Tz
MDGs	Millenium Development Goals
MVIWATA	Mtandao wa Vikundi vya Wakulima Tanzania, (Network of Farmers Groups, Tz)
OVI	Objectively Verifiable Indicator
NGO	Non Government Organisation
NPPAC	National Plant Protection Advisory Committee (NPPAC)
NRI	Natural Resources Institute, UK
NRIL	Natural Resources International
PADEP	Participatory Agricultural Development and Empowerment Project (World Bank funded)
PARTS	Pesticide Approval and Registration Technical Subcommittee, Tz
PH	Post-harvest
PHS	Plant Health Services, Tz
PHMS	Post-Harvest Management Services, Tz
PM	Project Memorandum
P,M&E	Participatory Monitoring and Evaluation
PPA	Plant Protection Act, Tz
PRA	Pesticide Registration Authority, Zw
RALG	(Ministry of) Regional Administration and Local Government, Tz
RMT	Researcher Managed Trial
SADC	Southern Africa Development Community
SSA	Sub-Saharan Africa
TPRI	Tropical Pesticides Research Institute, Tz
Tz	Tanzania
UZ	University of Zimbabwe
VEO	Village Extension Officer
VL	Vertical learning
w/w	weight for weight
ZFU	Zimbabwe Farmers' Union
ZPHOs	Zonal Post-Harvest Officers
ZPPOs	Zonal Plant Protection Officers, Tz
ZRELOs	Zonal Research Extension and Liaison Officers, Tz
Zw	Zimbabwe

Section A Executive Summary

'Small-scale farmer utilisation of diatomaceous earths during grain storage'

What are diatomaceous earths?

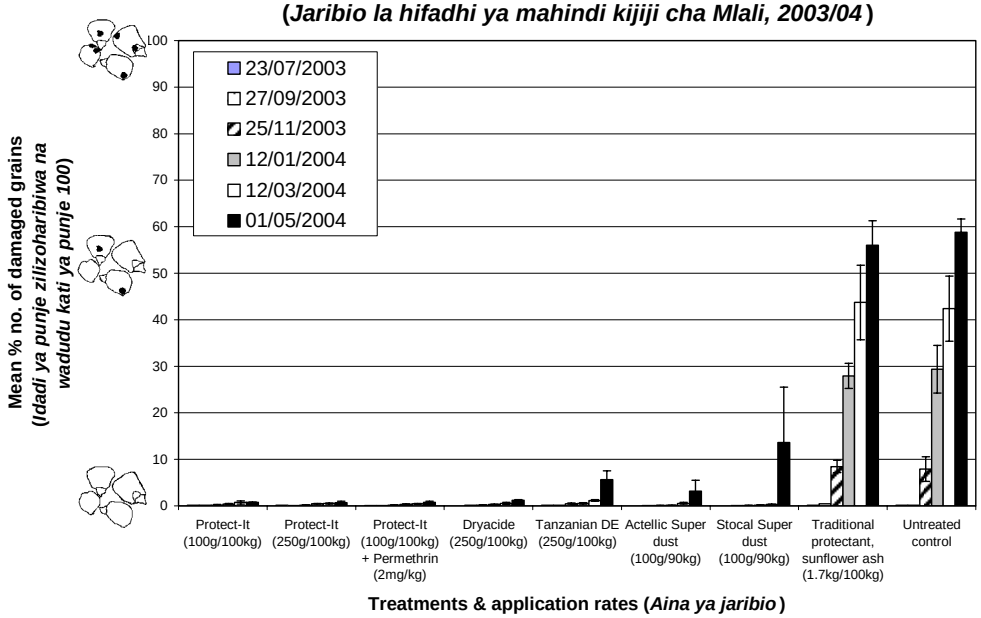
Diatomaceous earths (DEs) are soft whitish powders formed from the fossils of tiny planktons which live in oceans, rivers and lakes. These fossil deposits can be mined, ground to a powder, dried and admixed with grain to kill the insects that infest and attack it. When DEs come into contact with insects they absorb the wax from the skin of the insect, causing water loss, dehydration and subsequent death. Diatomaceous earths have extremely low toxicity to mammals and are therefore very safe to mix with food.

What did the project do and how?

Farmers throughout sub-Saharan Africa suffer serious losses to their stored produce due to insect damage. For many people these losses threaten household food security or undermine market returns, driving them to seek options for protecting their grain during storage. In addition to many of the traditional storage protectant practices such as admixing with ash or plant materials, and funds allowing they can purchase synthetic chemical pesticides. The main one is Actellic Super dust, an organophosphate-pyrethroid cocktail, but many other similar cocktails have recently entered the market. Unfortunately, since the distribution of these products was privatised, farmers have experienced widespread adulteration problems. In response to farmers' demands for alternative grain protectants, CPHP funded research in Zimbabwe (R7034) from 1998 -2000 which found that DEs were effective grain protectants against insect damage for small-scale on-farm storage systems. Further work to evaluate these fossil dusts was then initiated in Tanzania (R8179) where the devastating larger grain borer (LGB, *Prostephanus truncatus*) is already widespread.

Research trials were conducted in three regions of Tanzania (Shinyanga, Dodoma, Manyara) and in three districts of Zimbabwe (Buhera, Binga and Harare), to test and compare the efficacy of a number of different grain protectants (including African DEs) at protecting grain from insect damage during storage under different agro-ecological zones. These comparative tests have been run for two consecutive 10-month storage seasons during 2002-2004, and a third season is underway. The treated commodities include maize, sorghum, beans and cowpeas.

Maize grain protection trials, Mlali village, Kongwa district, Tanzania
(*Jaribio la hifadhi ya mahindi kijiji cha Mlali, 2003/04*)



These researcher managed storage trials were analysed for insect presence and grain damage on a bimonthly basis and occasionally evaluated by individual farmers during the 10 month storage period. The efficacy of DEs impressed research and extension staff and the participating farmers.

During the second and third years of the project, selected farmers tested the DE, Protect-It, in their own homes. The project team developed its skills to work with these farmers to learn not only about the effectiveness of DEs under farmer management but also to explore whether they meet the farmers' wider requirements, and to learn about the factors that influence different farmers' post-harvest decision-making. The team became aware that relatively little information was available on post-harvest decision-making and so developed a methodology for learning how different households by composition and/or gender, capabilities and access to resources, livelihood activities, and production levels; access and share storage knowledge and what storage practices they deploy. The capacity of intermediate agencies to share information with rural households and influence policy was also explored. Key grain storage stakeholders at the project locations have been identified, and a preliminary analysis of the quality and quantity of information networks and flows amongst intermediate users is planned.

Following the success of the earlier field trials in Zimbabwe, a private company has applied for temporary registration of Protect-It as a grain. However they are experiencing serious delays as a result of the current situation there. In Tanzania, awareness raising visits have been made to key stakeholders, and several private sector organisations are already showing interest in registering DEs as grain protectants. However the registration process has been discovered to be much more complex than originally anticipated. Registration is the major bottleneck facing the promotion of DEs now, and although the project is doing everything it can to facilitate this it is well aware of the need to remain independent.

Although the DEs, Protect-It and Dryacide come from North America, DE deposits also exist in East and Southern Africa. During the first year of the project DE samples from Tanzania, Zimbabwe, Zambia and South Africa were tested for efficacy against storage insect pests in laboratory trials. In Zimbabwe, the samples were collected by a private company that is eager to start mining the DEs not only for use as grain protectants but for other industrial uses as well. The results were promising and two of these samples were included in field trials during the 2nd and 3rd storage seasons. It is perhaps too early to speculate about the benefits a locally available diatomaceous earth may have for small-scale farmers, before additional qualitative, environmental, economic and other studies are made.

Information dissemination

The project is keen to ensure that the knowledge generated is widely communicated and made available to end and intermediate users in forms they can utilise and adapt. Key dissemination strategies have included: local language village notice boards; project flyer; project and CPHP newsletters; TV and radio programmes, convening workshops with farmers, extension staff and other stakeholders, training workshops, technical presentations at national and international fora. Along with these materials, a project website incorporating much of this information has been developed http://www.nri.org/de/.

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Section B Background

B.1 Administrative data

NRIL Contract Number: ZB 0299	Managing Partner/Institution: Natural Resources Institute, UK
DFID Contract Number: R 8179	Partner institutions: Ministry of Agriculture and Food Security, Tanzania: Plant Health Services & Post Harvest Management Services; Tropical Pesticide Research Institute University of Zimbabwe EcoMark Ltd, Zimbabwe Diatom Research and Consulting, Canada Institute of Agricultural Engineering, Zimbabwe
Project Title: Small-scale Farmer Utilisation of Diatomaceous Earths During Storage.	Target Institutions: Ministry of Agriculture and Food Security, Tanzania: Plant Health Services & Post Harvest Management Services; Extension Department; Tropical Pesticide Res. Inst. Ministry of Agriculture and Rural Development, Zimbabwe: AREX, Dept of Agricultural Engineering and Technical Service, Plant Protection Research Institute, Agrochemical companies interested in grain protection University of Zimbabwe, NGOs involved in grain & seed storage.
Research Programme: Crop Post-Harvest	Start Date: 11/06/02 End Date: 31/01/05
Thematic area: Food security: reducing storage losses on-farm	Budget: £300,567

Section C Identification and design stage

Project identification

The original idea for the project stemmed from the intriguing proposition that diatomaceous earths (DEs), which have multiple domestic and industrial applications in the developed world, might too be of significant use as grain protectants to small-scale farmers in sub-Saharan Africa. A simple idea, but a quantum leap in thinking, which introduced the possibility of a new and safer solution to a known and persisting problem. Initial field trials in Zimbabwe under the earlier project R7034 confirmed that DEs offered an alternative to organophosphate insecticides and were effective in controlling post-harvest insect pests in maize, sorghum and cowpeas stored for >8 months. The current project (R8179) aimed to verify these findings under semi-arid conditions in Tanzania where producers had constantly prioritised storage losses, and where the devastating larger grain borer (LGB, *Prostephanus truncatus*) was endemic. It followed then that the initial priority of the design was to demonstrate the efficacy and potential applicability of DEs with sufficient rigour and robustness within this new context. If DEs were not efficacious then issues relating to their suitability were irrelevant.

In the current project the paramount focus was initially to build on the earlier laboratory and field work and demonstrate efficacy (and safety) at village level in an area where the larger grain borer (LGB, *Prostephanus truncatus*) was endemic. This process was also essential for meeting the regulatory requirements associated with food treatments. It was realised that there might be economic and environmental advantages if local/regional DEs could be accessed and used by farmers as safe grain protectants. If DEs were to provide a grain protection solution for small-scale producers, it would also be necessary to explore community diversity and identify household circumstances under which DEs would be suitable. To this end the earliest design envisaged broad stakeholder involvement and the inclusion of social studies.

Poverty focus

How did the project aim to contribute to poverty reduction? Was it enabling, inclusive or focussed[1]? What aspects of poverty were targeted, and for which groups?

Poverty has been conceptualised in many different ways, and is associated with a diverse terminology - income or consumption poverty, human under-development, social exclusion, ill-being, lack of capability and functioning, time poverty, vulnerability, unsustainable livelihoods, lack of basic needs, relative deprivation. The different concepts of poverty derive from its multiple dimensions and sundry contexts. There is a basic divide between income, consumption or expenditure definitions, which emphasise physiological deprivation, and definitions which emphasise social deprivation (e.g. entitlements theory, social exclusion approach). The latter views poverty and/or its indicators as going beyond income levels to include access to health care and education, respect, status, isolation within a community, and feelings of powerlessness and hopelessness.

By one analysis, and in line with the perceptions of many in-country practitioners at different levels, the majority – or certainly a sizeable minority - of households in the various project 'villages', could be considered 'poor'; and by this definition the project's contribution to poverty reduction would be considered to be enabling.

The 'pro-poor' concept itself has promoted discussion within the project, and amongst farmers. On one hand there are, for example, different understandings of poverty - 'we are (almost) all poor here', is frequently heard at the village level', and cannot be gainsaid against Western consumer patterns - and on the other there is often an element of 'gamesmanship' when it comes to responding to the donor driven agenda on poverty, the Millennium Development Goals; smart movers are *au fait* with donor conditionality and the associated jargon, but hold their own, quite different opinions on what constitutes poverty.

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[1] **Enabling**: addresses an issue that under-pins pro-poor economic growth or other policies for poverty reduction which leads to social, environmental and economic benefits for poor people
Inclusive: addresses an issue that affects both rich and poor, but from which the poor will benefit equally
Focussed: addresses an issue that directly affects the rights, interests and needs of poor people primarily

The team's perception and understanding of poverty developed over the period of the project, which in turn prompted developments to the design.

Please describe the importance of the livelihood constraint(s) that the project sought to address and specify how and why this was identified.

The project aimed to contribute to poverty reduction through the provision of a means to increase the food security of households and/or enabling households to maintain the quality of their stored grain for longer and hence secure better prices. Storage losses (in terms of both quality and quantity) have been constantly prioritised by small-scale producers in semi-arid areas of Africa, and their implications for household food security, income requirements and opportunities are significant. The project aims included demonstrating that there was an effective, safe and non-organophosphate-based alternative - DEs - to the potentially harmful and frequently adulterated synthetic pesticides that many farmers are presently obliged (and advised) to rely on.

How and to what extent did the project understand and work with different groups of end users?

The project recognised from the start that some households - usually the poorest in a village - do not manage to produce enough food to actually store it for any period of time and therefore might not be able to immediately or directly take advantage of opportunities to improve the quality of their stored food. Initial studies showed that members of these households were likely to be working as labourers in return for grain or cash during the period when their own food had finished, and it was therefore speculated that if the nutritional or seed quality of the grain they were paid in was improved as a result of better grain storage options being used by the households hiring them, then the benefits would indirectly be felt by some of the poorest households. Little factual information however was known about what proportion of households in different areas of Tanzania harvested too little to store, just how little did they harvest, and what were their alternative strategies for obtaining food until the following harvest.

To address this knowledge gap, key informants in the trial sites were asked to describe the indicators used locally to differentiate between households of different wealth groups, and to estimate the percentage of households in the village which belonged to each of the different wealth groups, details of which are presented in Tables 1 & 2 below for trial site villages/ wards in Tanzania and Zimbabwe respectively.

Table 1. Indicators used by key informants to distinguish between the different wealth groups in Mwamakaranga village, Shinyanga district, Shinyanga region, Tanzania, May 2003

Village (District, *Region*)	**Lower wealth households**	**Middle wealth households**	**Higher wealth households**
Mwamakaranga, (Shinyanga, Shinyanga)	They often rent their farms They usually don't own oxen They work as labourers on others fields Living standards are low. They can't manage the costs of medical treatment, school fees, new clothes, bicycles, or good houses etc They use traditional technologies for storage e.g. application of ash Their marriages are often not stable, as the wives often leave to look for better lives	They own and farm more than 3 acres They usually have 4 oxen, and a plough, if they don't they may share with another household They live in moderate houses with good thatched roofs They own at least one bicycle There are at least two wives	They farm and own more than 10 acres They are rich, they have 8 or more oxen and 2 to 4 ploughs They often adopt modern farming methods/ technologies Most of them have a modern house built of fired/ burnt bricks with a corrugated iron roof They contribute more than the other wealth groups towards the development of their village, e.g. cash or lending oxen etc There are always two or more wives in the household They have more than one bicycle for different activities They own assets like vehicles, milling machines and can purchase crops from other farmers
% of HH in this gp	Approx. 20%	Approx. 70%	Approx. 10%

Table 2. Indicators used by key informants to distinguish between the different wealth groups in Ward 4, Buhera District, Zimbabwe

Household wealth category	Farm criteria	Off-farm criteria	Social criteria
Better-off	Own farm implement such as ploughs, harrows, planters Own scotch cart Own cattle; 8+ including at least 4 for draught power Actively involved in gardening	Involved in trading of basic household items such as soap, cooking oil Involved in value addition to crops such as peanut butter processing	House roofed with asbestos or corrugated iron sheets Have at least 4 buildings at the home. Children going to school Large family size Older generation
Medium	Own either plough and/or enough cattle for 1 span Actively involved in gardening	Involved in brick-moulding Semi-skilled labour eg builders Involved in trading of basic household items such as soap, cooking oil Involved in value addition to crops such as peanut butter processing	Middle-age Medium size family
Poor	No garden No farm implements Rely on labour parties or group work (*Nhimbe*) to get farm work done	Provide casual labour to medium and better off categories Brick moulding	1-2houses/huts Children go to school erratically or are not going to school Younger generation Small family School leavers

Discussion of these issues highlighted the limited understanding of farmer diversity as regards post-harvest decision making and different livelihood options within the trial areas. Understanding grain storage issues is particularly difficult because of their private nature. In the case of field crops or livestock it is possible to get a feel for what is happening from direct observation. The same is not true for storage practices. While they are initially characterised by discreet activities, mostly undertaken in public (e.g. threshing, winnowing, treating), they typically culminate in secluded storage and/or sale arrangements. Perhaps because post-harvest activities are directly linked to household food security and survival, and/ or to profit and well-being, their understanding tends to be a much more private affair, with quantities and qualities of grain stored neither readily disclosed by farmers, nor obvious to others.

This led the project to invest in developing a methodology and an enquiry tool to help ourselves and other services providers to learn in detail about factors affecting households' post-harvest decision making and their diverse circumstances.

We now have an increased understanding of the complexity of rural poverty in the districts in which we have been working. We also have a better idea of the range of farmers for whom DEs might be relevant and affordable (assuming a price close to that of Actellic Super Dust (ASD), say).

Describe the design for adoption of project outputs by the user partners?

Until registration of DEs as grain protectants is completed, no real scaling-up of the work can be achieved; however there is already strong demand by farmers and other stakeholder involved and aware of the trials who want to be able to purchase these highly effective products locally both in Tanzania and Zimbabwe.

The unfolding design for adoption of the project outputs has focused on two main areas: delivery constraints on the one hand; and farmer decision-making on the other.

With respect to delivery constraints project design and processes have given emphasis to issues associated with regulation and policy, registration in particular, and to a lesser extent to implementation strategies and practical dissemination. To facilitate this, the project adopted the strategy of 'co-opting' strategic intermediate stakeholders (e.g. TPRI staff, district and sub-district extension staff from state and voluntary service providers) into the working alliance. It was anticipated that while increasing the number and diversity of stakeholders involved real

costs (e.g. to resources, straight-line or task progress), done strategically it could also bring about transformational change (e.g. TPRI and registration). In the pre- and early project stages emphasis had been given to identifying and engaging with stakeholders through handouts, meetings and workshops.

A similar approach was adopted with respect to up-take by farmers. It was always planned to seek the earliest involvement of farmers in the trial villages, whether as hosts and assessors of the storage experiments, suppliers of grain and other materials, contract labour to help set up the researcher managed trials, or as local experts and advisors. The need to develop a better understanding of household diversity and farmer PH decision-making inexorably led to greater emphasis on *farmer participatory approaches* and *livelihood approaches*. The adoption of these approaches and design of an *enquiry tool* with which to develop understanding of farmer decision-making and potential uptake opportunities were undertaken in a participatory way by (sections of) the team.

Institutional design

Describe the process of forming the coalition partnership from the design stage and its evolution during the project?

The conception and design phases of the project were largely driven by the project leader, with support from key personnel in the two study countries, Tanzania and Zimbabwe, who subsequently became the in-country leaders. These alliances, which were initially based on personal connections, were subsequently shaped and developed into a wider 'coalition' to accommodate the implementational needs of the research, and later to meet promotional requirements.

The coalition comprised the core team[2], plus those partner agencies, individual farmers and farmer groups who were variously engaged in project activities & processes. The core team was characterised by various features including: a predominance of scientific or technical personnel with one social scientist; a North-South split; the predominance of public sector service providers, and in Tanzania no representation from (mainline) public sector research; technical staff, from all levels within the sector (i.e. national, zonal, regional, district/ municipal, and village), were asked to put into practice new approaches and skills associated with social science; two study countries, but greater core team focus on Tanzania; and all team members being part-time workers on the project.

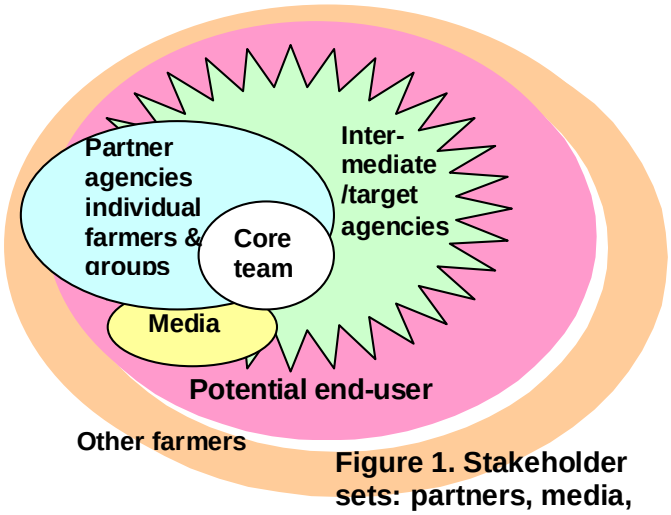


Figure 1. Stakeholder sets: partners, media, intermediate & end-users

Individual's 'profiles' changed as the project unfolded for a variety of reasons, some project related (e.g. switch of output focus) others personal (e.g. promotion, transfers, health, study leave, maternity leave). Regarding changes in the importance of partners: for 'core' partners (i.e. those who were always recognised as being key to the project realising its purpose) it was perhaps the development of understanding amongst team members of the 'importance'

[2] The core team includes: active researchers - natural and social scientists - from NRI and the University of Zimbabwe; ministry of agriculture staff (PHS, PHMS, TPRI, AREX, IAE) at central and regional levels, with implementational remits, but also research experience; and local level, public and voluntary-sector, extension staff. The coalition has formally expanded since its inception, with key additional individuals and organisations (TPRI) joining the ranks in response to strategic demand and mutual interests.

of these partners that changed. Working together built individual bonds, but also a more realistic awareness of the organisations with whom others work. New partners however, were included both for their tactical contributions and their strategic potential. Aside from joining itself, the strategic component clearly suggested an increase in importance of that partner, for example the inclusion of the TPRI in the coalition was an acknowledgement of the importance of the TPRI to the realisation of project purpose, and specifically the registration of DEs in Tanzania. Likewise, the inclusion of the Ministry of Energy and Minerals in Tanzania and private mining companies in Zimbabwe with respect to the potential of local DE deposits.

The project was developed on the back of an earlier project which was oriented toward scientific objectives and hence its paramount technology focus. However the project design was conceptualised and intended to be broadly inclusive and to explore and emphasise the processes associated with innovation as much as the development of the product. This was confirmed by the inclusion of a social scientist specialised in institutional and social development. Earlier discussions moreover revolved around whether the institutional components would be run separately from the main scientific research using additional 'social' expertise, or whether the predominantly technical team would be incorporated in this work; the latter prevailed. In line with this interest to understand system development and in addition to scoping the envelope for the chosen technology, Ouput 3, which initially related to 'farmer validation' of the specific technology was revised - re-designed. After some discussion it was agreed to switch from the technology (or crop) focus, that has long predominated in this type of research, to a farmer-centred approach. The new output focuses on developing understanding of farmer decision-making, and the development of tools to facilitate this.

Is there an explicit institutional hypothesis? If yes, is it trying to attack a failure or inadequacy in a mechanism?

Originally there was no explicit or jointly held institutional hypothesis. As indicated above the involvement of different stakeholders at different operational levels (e.g. national, regional, district, village) was sought on the understanding that such arrangements would facilitate implementation and/or subsequent scaling up. The engagement of NGOs (e.g. FARM-Africa in Babati) was to benefit from their village-level contacts and experience, and to complement or make up for deficits in state service provision. The involvement of the TPRI was explicitly to facilitate - or overcome obstacles to - registration.

What other institutional factors were seen as being important?

- Monitoring activities against output performance.
- Understanding and monitoring process performance.
- Facilitating vertical learning (VL) or overcoming constraints to VL:
  - Building trust between team and farmers and farming communities.
  - Research methods and farmers' research - use of farmer validation experiments to bridge epistemological differences
  - Decentralisation - bridging gaps between state service provision and recipients, or creating gaps between line ministry hierarchies?
  - Ensuring senior personnel in MAFS and AREX on side.
- Facilitating horizontal learning (HL) or overcoming constraints to HL:
  - Finding ways to ensure that scientific and social components are mutually reinforcing (in terms of higher level objectives)
  - Participation of technical team in development of social enquiry work
  - Developing links with private sector.
  - Combining 'research' and 'practice'

Section D Implementation process

How was participation maintained among the different stakeholders (the Managing Partner(s) and the Core other Partners and, where relevant, user communities) in the research process?

In nearly all cases the core team was actively involved in field activities and therefore physically came together regularly to set up or sample, analyse/ evaluate trials, plan the next activities etc. There is however some differentiation within the core team indicated by access to and use of communication. There is an inner group to whom all documents and project issues are circulated and discussed either electronically, or physically if there is the opportunity to be together, or by mobile phone. Because so much of the communication happens electronically this effectively excludes those team members without email access, however progress has been made over the last two years by bringing two more of the team members online, and by supporting (with an internet cafe budget) those who previously could not always access email when they wanted to. As management decisions differ, e.g. some must involve the whole team, others such as arranging a trial site visit or planning a sampling date need only involve a few of the team members, it is difficult to generalize, but where possible issues are raised electronically by one of the team members and others are free to contribute their thoughts. The ensuing decision-making by management is generally informed by the interests and views of the wider team leading to a high degree of ownership and participation amongst the core team.

The project is contracted to deliver against the output objectives in the project logframe. This responsibility resides both legally and effectively with the project leader, who in effect acts as the project manager, with sub-managers at the national level. Generally team members are identified as having specific responsibilities for the given activity sets associated with particular outputs. In the case of output 1 for example, which is essentially 'technical' in nature, roles and responsibilities were clearly specified (with room for individuals to take on wider responsibilities), and management has generally been by delegation. Information necessary for the analysis is then fed back to the scientists. Some discussion and changes in these arrangements are always possible, and flexibility and some functional 'redundancy' is essential for completing tasks according to plan.

Experience and exposure have perhaps pointed up some of the limitations of the original activities associated with output 3, establishing DE user acceptability, to a lesser extent outputs 4 and 5, dissemination and promotion respectively, and output 6, PM&E, and changes have been made to the logframe. These outputs have invited more of a process approach – action and reflection, learning by doing, participatory derived performance indicators – which has necessitated a different management style.

What were the major changes that took place during the implementation period. For each one, explain why they came about and how well did the project manage them?

The major changes might be divided into two main categories: unplanned and/or unexpected changes determined by factors beyond the control of the project (i.e. those that might be located in the risks & assumptions column of the logframe); and, those changes wrought or contrived by the project itself in response to other events, in which management was on the front foot. The ability of the project to 'think on its feet', be reactive and responsive, replacing prescribed tasks with process, was circumscribed by resource and time constraints.

The following depicts responses to the former, unplanned changes:

- Changes to strategic staffing brought about by restructuring in the Tanzanian Ministry of Agriculture and Food Security. Initially the project was at the 'mercy' of such changes, but subsequently it was felt that the standing of the project was such that team changes could and would be resisted. Restructuring of the Tanzanian Ministry of Agriculture and Food Security to form a Post Harvest Management Services (PHMS) under a new Directorate of Food Security just after the beginning of the project. The project had been designed to be led in Tanzania by the Plant Health Services (PHS) in the Directorate of Crop development, who at that time had the mandate for protection of stored food from

insect pest damage. Both for tactical and strategic reasons the project brought key members of PHMS on-board, and they are still involved although staffing issues as a result of sickness and study leave have led to the continuous changing of the key contact person.

- Restructuring of the Zimbabwean Ministry of Agriculture and Rural Development to combine the former Departments of Agritex and Research & Specialist Services to form Department of AREX and creation of Department of Agricultural Engineering and Technical Services (AETS) took place over a long transitional period, creating staff uncertainty. Further restructuring within AETS left many posts without substantive heads e.g. Post-harvest Management of Produce branch, which has been disruptive to project implementation and the project ended up dealing with junior staff.
- Bureaucratic 'drag': realisation that the registration system for example wasn't going to be straightforward. Team efforts to move things forward were 'doubled', and various tactical plans explored to raise the registering institution's first hand awareness about the DE trials, their efficacy and farmers' demand.
- The rapidly deteriorating political, social and economic situation in Zimbabwe particularly during the first two years of the project. Team members (particularly the Zimbabwean in-country leader) took substantial personal risks in order to ensure field activities happened, including the difficult procurement of grain and fuel, the setting up of farmer research groups, and the transporting of foreign currency.

Major changes wrought by the project include:

- The radical overhaul of Output 3, which moved the focus from 'farmer validation' trials based on research methods to developing understanding of farmer decision-making in the context of household diversity. In an otherwise closely defined schedule, the proposed change and the participatory development of the methodology exposed many team members to new ideas, and were in contrast to the relatively tightly defined schedule for other activities. At this stage however the merit of the change and of the hard work it entailed is being appreciated.
- Participatory planning exercise in Year 3: This was conducted to review project progress to date from different stakeholders perspectives, improve the integrated planning of activities within other schedules, and to help increase involvement and ownership of the project by a wider group of partners (as opposed to just the core partners).
- The need for a third year of field trials in Manyara and Dodoma regions. Results from the second year field trials necessitated further testing of some of the treatments in some locations, and so although not initially planned a third season of field trials were set up with all the associated time and resource implications.

What were the strengths and weaknesses of your monitoring system? How did you use the Information provided by your monitoring system?

The project complied with the formal quarterly and annual reporting system stipulated by CPHP, whereby the progress of the planned activities was detailed against their respective milestones. These quarterly reports were written collaboratively by the core team, with the project leader circulating an initial draft that was then improved on by team members, several drafts were circulated prior to submission. This shared report writing process gave opportunity to comment on the plans and progress of activities, interesting unplanned spin off activities, forthcoming problems, significant coalition events and to ensure all team members were aware of each others activities.

Regular (almost daily) email communication between four of the core team members has enabled constant monitoring of progress and shared problem solving and decision making.

Face to face meetings, text messages and mobile phone calls have also played a critical role in the monitoring process.

Four participatory monitoring and evaluation meetings/ workshops (and a review workshop organised by the team to facilitate the external reviewer's (Prof. D. Giga) evaluation of the projects progress in August 2003) have provided additional focused opportunities to constructively discuss issues as they have arisen in the project and to suggest workable solutions and to later reflect on whether these solutions are addressing the initial constraint or whether further suggestions are needed.

All information gained through the above processes was used to inform decision making and planning. Different claims were often passionately contested, but the fact that we all look forward to the follow-up project suggests that reason, good humour and good management prevailed.

What organisations were involved at the end of the project? Were there changes to the coalition (joining/leaving) during the project? If yes, why? Include a complete list of organisations involved, directly or indirectly, in the project and describe their relationships and contributions.

Table 3. The original project partners, their roles and changes

	Initial coalition members	Changes	Current coalition member
UK	Tanya Stathers, NRI, UK Scientist and project leader		Same
	Mike Morris Institutional and social development specialist		Same: increased involvement in later stages
Tanzania	Victoria Kisamfu & Deusdedith Mathias Plant Health Services Division, MAFS, Tanzania. Technical staff with great in-country knowledge	Mrs Kisamfu stepped in as in country coordinator when Mr Riwa moved to be the acting private secretary to the Minister, however in 2002 she left for a 3 year degree in Ireland. Mr Mathias was involved in developing the project memorandum and then got promoted to national coordinator for the Post-Harvest Management Services in August 2002, but has stayed in touch though not heavily involved in the project. He has now started a 3yr degree at SUA. Rachel Mosha joined and took over Mathias' project responsibilities in Nov 2002, from her base at the Port Customs & Quarantine Inspection office. Mr Riwa who had been involved in the concept note but then temporarily changed roles, returned to PHS and took over from Mr Matthias at the start of the project. Mr Kitandu has been involved in the project since Aug. 2001 during the development of the proposal and manages the Shinyanga-based activities. Mr Mngara has been involved in the project since Aug. 2002 and manages the Babati-based activities.	William Riwa (in-country project coordinator) Rachel Mosha, Lazaro Kitandu, Kihedu Mngara Plant Health Services MAFS, Tanzania
		Adella Moshy, Head of Post-Harvest Management Services, Tz, has been intermittently involved with coalition – presently not available due to ill-health	
		Inclusion of Dr Kaoneka for both tactical (adds to scientific base) and strategic (key player in registration processes)	Dr Kaoneka Tropical Pesticides Research Institute, MAFS. Scientific inputs and advisor re 'registration in Tanzania

	Zonal, regional & district level coordinators (Western Zone – Mr Martin Katua; Central Zone – Mr Damion Gassana; Northern Zone – Ms Salome Munisi) provided additional logistical and technical support to participating extension staff in Shinyanga (Mr Karega), Dodoma (Mr Materu) & Manyara (Mama Msoffe & Mr Maige) regions respectively. These extension staff have great regional knowledge, plus many were involved in the historical LGB campaigns. Shinyanga staff helped develop the project memorandum along with staff from 6 interested NGOs in Shinyanga.		
	Village level extension, strong local links, good position for regular monitoring of project activities at village level. Mlali village – Mr Lyimu & Mr Isere Arri village – Mr Mtete Mwamakaranga village – Mr Biyagela Mwataga village – Mr J. Mwamnyange	Many of the village based extension staff have been transferred or gone for further studies during the course of the project.	Mlali village – Peter Mkwiya Arri village - Mr Mayansi Mwamakaranga village – no-one until Mr Biyagela returns from study leave
Zimbabwe	Brighton Mvumi Department of Soil Science and Agricultural Engineering, University of Zimbabwe Scientist and in-country coordinator		Same
	Jonas Chigariro Post Harvest Technology, Institute of Agricultural Engineering, Zimbabwe.	Departed for Namibia; there was no replacement for a long time and then Mr. Rodwell Kashoti was assigned to work on the project and was involved in setting up the 2003/04 trials at IAE but was later re-assigned to another section; In 2004, re-structuring brought in Mr. Tirivangani Koza as acting head of Postharvest Management of Produce at IAE but was later moved to head another branch after participating in setting up RMTs at IAE and FMTs in Buhera.	Sipho Sibanda now acting head of Postharvest Management of Produce at IAE since mid2004 and will be directly involved in the project through in-service training of extension staff in early 2005.
	Maurice Mudiwa Department of AREX, Zimbabwe.	Left to work for FAO emergency food distribution programme in Zimbabwe	
	Elijah Dube, Department of AREX, Buhera District	Transferred to provincial level. Not yet certain whether the project will be able to continue tapping on his long experience in the project.	3 new members from Dept of Agricultural Engineering and Technical Services joined Buhera District from agricultural colleges.
	District/Ward level extension, strong local links, good position for regular monitoring of project activities at ward level: Angeline Madenyika, Kundai Machimbidza & P. Shiri (AREX – Buhera); Alex Zhou (AREX – Binga)		
	Rodrick Kuseri IAE	Working in another section but can still offer his expertise by arrangement	
	David Zinyengere Managing Director, EcoMark Limited Zimbabwe	Initially moved to be based in Zambia as regional manager. Currently no longer an employee of Ecomark though he still consults for the company.	Lewis Muhwati (Export Business Manager) took over responsibilities of grain protectants issues and is pursing the registration of Protect-It.
Other	Zlatko Korunic Diatom Research and Consulting Canada	Dr Korunic was involved in the initial laboratory screening of the African DEs as this is his area of expertise.	

Table 4. Other organisations involved in the project

	Organisation(s)	Involvement in the project
Tanzania	CARE Magu District Livelihood Security Project, World Vision Tanzania, Oxfam, Shinyanga Youth Advisory and Development Council GTZ-IPM project Shinyanga, Kahama and Shinyanga Agricultural Extension Services, Catholic Diocese of Shinyanga Agricultural and Rural Development Programme, Shinyanga Regional Agricultural Advisers Office Shinyanga Regional Nutritional Advisers Office Stockists (Mfanga Agrovet Agent, Mussula agrochemicals) Strategic Grain Reserve Community Development Trust Fund Shinyanga Municipal Council Lake Zone ZRELO	Participation in project design workshop and/or stakeholder workshop and/or project review workshop. Visit to Mwamakaranga and Mwataga trial sites including discussions with farmers involved in the trials. Regularly updated on project progress, recipients of newsletters and fliers, discussions with project team about project progress
	Balton Tanzania Ltd Twiga Chemicals Mukpar (T) Ltd	Private sector agrochemical organisations who have shown interest in the projects findings and are potential registrants of DEs in Tanzania
	Media (Star TV, Radio Free Africa, Radio Tanzania, Sauti ya Dodoma)	Published or broadcast information about the project following interviews with project team or farmers involved in the project
	Ministry of Minerals and Energy	Location of DE deposits in Tanzania, collection of DE samples that were then used in the project, regular updating on projects progress verbally by in-country leader.
	Farm Africa, Babati	Briefed on the planned project activities prior to project starting, involved in initial site selection in Babati, working with an existing farmer research group in Arri village, regular updates on project progress, visits to assess trial progress in Arri village.
Zimbabwe	KMTC, Binga	Local NGO; hosting the Binga DE RMTs; used DEs in protecting their own grain, farmer training centre. Regularly updated on project progress, recipients of newsletters and fliers, discussions with project team about project progress at least every eight weeks during sampling of the trial.
	Save the Children -UK (International NGO)	Participated in setting-up the RMTs in Binga and subsequent sampling.
	FACHIG, Mashonaland Central and Manicaland Provinces (Local NGO)	Participated at the farmer workshop held in Buhera.
	Plant Protection Research Institute, AREX	Pesticide Registration Authority, participated at the farmer workshop held in Buhera
	Training Branch, AREX	Participated at the farmer workshop held in Buhera; recorded radio programmes at the workshop
	Dorowa Mining Ltd & Zimbabwe Phosphate Ltd.	Private sister companies, located DE deposits in Zimbabwe and collected raw DE samples for the project; participated at the farmer workshop held in Buhera; have shown great interest in developing local DEs as grain protectants amongst a range of other DE products. Regularly updated on project progress, recipients of newsletters and fliers, discussions with project team about project progress.
	Independent consultant, Prof. Denash Giga	Mid term reviewer of project, visit to trial sites in Shinyanga

How will(have) project outputs affect(ed) the institutional setting? How will the technical outputs of the project (if successful and if adopted) change the organisations and the relationships between them and in what way? Refer to the project's technical hypothesis.

Whilst the paramount scientific objective was to demonstrate the efficacy of DEs in different agro-ecological zones, the original project hypothesis also referred to their 'acceptability', and the provision of 'an alternative to the use of organophosphate chemicals'. To test these propositions the project has not simply built alliances with key stakeholders, but has also arguably built up organisational capacity and individuals' capabilities, and broadened the debate both about existing service delivery practices and about the recommended use of certain synthetic pesticides. In exploring the hypothesis that 'local sources of diatomaceous earths may produce a more cost-effective method of grain protection for small-scale

producers', the project has reinforced if not stimulated wide interest in various local deposits. We have recently discovered for example that initial interest shown by the Ministry of Minerals and Energy (Tz) in response to the project's enquiries (i.e. with respect to use in small-scale grain storage) is now also being driven by awareness of other potential uses for DEs (e.g. industrial applications).

Specific examples of capacity building include experience of: research trial design, methodological development, set up, monitoring, data management and evaluation; comparative efficacy of the different grain protectants already available and diatomaceous earths. Increased contact between institutions as a result of their involvement in the trials has led to stronger relationships, better understanding of the constraints faced by each. Indirectly, the project also enhanced the extension staff-farmer contact as the farmers were able to interact with the extension staff on a regular basis on other issues outside the project. MAFS will have seen the increased competence of PHS in managing and reporting on field trials. A further collaborative proposal was developed by some of the partners. The weaknesses and strengths of the different institutions have been highlighted. A methodology (enquiry framework) that can be easily adapted for use in learning about factors affecting decision making about different activities has been provided. The project has also allowed national institutions to respond to demands for a grain protectant that farmers can use to keep grain safe for periods of more than 8-10 months.

As always it is the individuals who comprise organisations who are key to the processes of generating new knowledge and technical outputs. Should such individuals, for whatever reason (e.g. relocation, study-leave, retirement), depart their organisations before the new processes are 'institutionalised' (i.e. become part of the fabric of know-how and practice) then organisational amnesia may occur and knowledge sharing falter. In this project new knowledge about DEs has been successfully promoted within and between key state organisations and 'wings' of those organisations, and with private sector players. 'Registration', which we believe to be on course, would be the crowning proof of this. Meanwhile, the DE case has highlighted the need for adaptation of the current Plant Protection Act to encompass the registration of products with non-chemical modes of action, and a promotional presentation to the private sector backed by the Permanent Secretary (Tz) is about to take place, both of which suggest the measure of the influence – and type of relationship - the project has had within MAFS.

Section E Research Activities

Output 1: Methods for the protection of grain using commercially-available diatomaceous earths (DEs) against damage by P. truncatus and other storage insects optimised.

Activity 1.1 On-farm field trials of commercially available DEs alone and in combination with very low doses of pyrethroid against *P. truncatus* damage in comparison with traditional grain protection methods in two sites in Tanzania over two storage seasons (2002/3 & 2003/4).

On-farm field trials to compare two commercial DEs (Protect and Dryacide), with other grain protectants (commercial synthetic pesticides, traditional protectants and samples of African DEs) were run in three regions in Tanzania (Dodoma, Manyara & Shinyanga) for two storage seasons, and for a third season in Manyara and Dodoma regions. As well as representing different agro-ecological zones the trial sites captured different farming systems and different storage cultures. In Mlali village, Dodoma region four farmers' stores were selected for replication of the treatments of maize stored in polypropylene bags of 100 kgs each. In Arri village in Manyara region, the village government provided a storeroom and the treated maize was stored in mini mud and stick woven baskets (granaries/ vihenge) of about 100kg capacity each. While in Singe village, beans treated with the different protectants were stored in mini jute bags of 20kg capacity in the village go-down during the first season and in a farmer's bedroom during the second season. In Shinyanga region, the treated maize and sorghum were stored in mini mud and stick woven baskets at a farmers homestead in Mwamakaranga village and in a school room in Kishapu village respectively.

While grain treated with traditional treatments or left untreated was severely damaged over a 10-month storage period, grain treated with DEs or synthetic pesticides bought from registered stockists suffered minimal damage (see graphs). The results demonstrate that Protect-It and Dryacide can be extremely effective and persistent grain protectants, against the major insect storage pests attacking maize, sorghum and beans, for storage periods of 40 weeks in the climatic conditions found in the three agro-ecosystems of the trial sites in Tanzania. However, it was concerning that at Arri village, Manyara region all maize treatments were heavily damaged in the 2003/4 storage season. It is likely that this was as a result of using heavily infested grain to set up the trial. As DEs are effective when insects come into direct contact with them, they should be used on freshly harvested, dry, non-infested grain only. In these trials no differences in efficacy between the 0.1% and 0.25% w/w application rates of Protect-It were evident on maize grain with the exception of the Arri trial mentioned above. However on sorghum, in the 2002/3 storage season of the DE treatments only Protect-It applied at 0.25%w/w and Protect-It in combination with permethrin dust kept insect damage low confirming earlier studies in Zimbabwe where higher concentrations of Protect-It were required on sorghum to protect it from damage by the bostrichid beetle *Rhyzopertha dominica*. The Tanzanian DE obtained from the Kagera deposit applied at 0.25%w/w effectively protected maize grain for 40 weeks of storage. This local DE was used again in the current 2004/5 storage seasons trial. When clean, dry grain was used only low damage levels were encountered in all the protectants treatments and the untreated control during the first 16 weeks of storage, indicating that the addition of grain protectants in these areas of Tanzania would be unnecessary for any grain which is to be stored for 4 months or less, unless pre-harvest infestation was high. However any grain that it to be stored for longer than 4 months should be treated immediately after harvest and drying to protect it against insect damage.

These findings were corroborated by farmers who used their own criteria to assess the quality of the differently treated stored grain (see activity 1.2). Selected farmers ran trials in their own homes, which also confirmed the effectiveness of DEs.

These trials have raised expectations amongst farmers and other stakeholders in the trial sites and there is strong demand for these safe grain protectants to be made available in Tanzania.

The interactive project field days held during the trial set up and evaluation and displays at agricultural shows have led to a large numbers of farmers, questioning and understanding the need to: thoroughly mix grain protectants with grain as opposed to sprinkling them on top; apply grain protectants as soon as possible after harvest as opposed to waiting until insects are seen breeding in their grain; apply grain protectants at recommended rates; check the expiry date on chemicals; if possible buy inputs from registered stockists to avoid adulteration issues.

Albeit a research project, the study's implementation itself helped families in trial sites have food till the next harvest, they said themselves they would have been hungry if they had not been involved in the trial and therefore keeping their maize for long term comparison and observation. Exposure to first hand experience of the possibility of storing grain safely may have much further reaching consequences. The trials have also provided labouring opportunities and knowledge acquisition on grain protectant admixing and storage. In fact, the services of several of the individuals who helped during the set up of the storage trials, have been demanded by other farmers, and they now operate a small business admixing grain protectants post-harvest.

Unlike in Zimbabwe where the initial DE grain protection trials were run (project R7034), the devastating larger grain borer (LGB, *Prostephanus truncatus*) is endemic in Tanzania. Following R7034, laboratory studies were done at NRI to determine the application rates of DEs needed against *P. truncatus*. This information was used to set up the field trials in Tanzania. During the course of the last three storage seasons very few *P. truncatus* have been observed in any of the DE treatments, despite having been found in the untreated control, traditional protectants and some of the synthetic pesticide treatments particularly towards the end of each storage season which is extremely encouraging. *P. truncatus* attack can be sporadic in that one store might be devastated while the neighbouring store remains undamaged and some years appear to be high *P. truncatus* years compared to others. It was for this reason that a small on-station trial was set up at TPRI in the 2004/2005 storage season. The storage structure was seeded with *P. truncatus* infested maize cobs in early January 2005. It is hoped that the findings of these trials will support the results of the laboratory and field trials about DE efficacy against *P. truncatus* infestation.

Following the 2002/3 storage season, the grain which had been treated and stored for 40 weeks at Mlali village, Dodoma region, Tanzania was subjected to a seed viability test. Forty

whole grains from each treatment were placed in clean petri dishes with two pieces of moist filter paper below them and one above them, four replicates were set up, the trial was run in April in Dar es Salaam under ambient conditions. Germination was assessed after 3 days. In all treatments and the untreated control, the mean % germination was above 70% and in the DE and synthetic pesticide treatments it was above 90% (see fig. 2h). There was no significant difference between the results of the DE or the synthetic pesticide treatments which is encouraging suggesting that DEs can be used to safely protect grain intended for seed as well as food. It should be noted that only whole grains were used in the trial, and given the high levels of insect damage to grains in the untreated control and traditional protectant treatments (fig. 2a) had a random sample of grains been used the % germination would have been much lower for these two treatments.

Figure 2a. Maize grain protection trials, Mlali village, Kongwa district, Tanzania, 2002/2003.

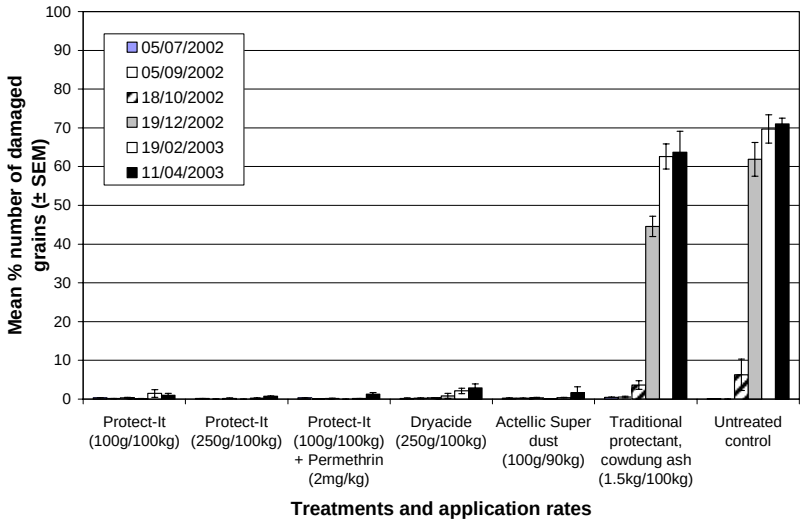


Figure 2b. Maize grain protection trial, Mwamakaranga village, Shinyanga district, Tanzania, 2002/2003

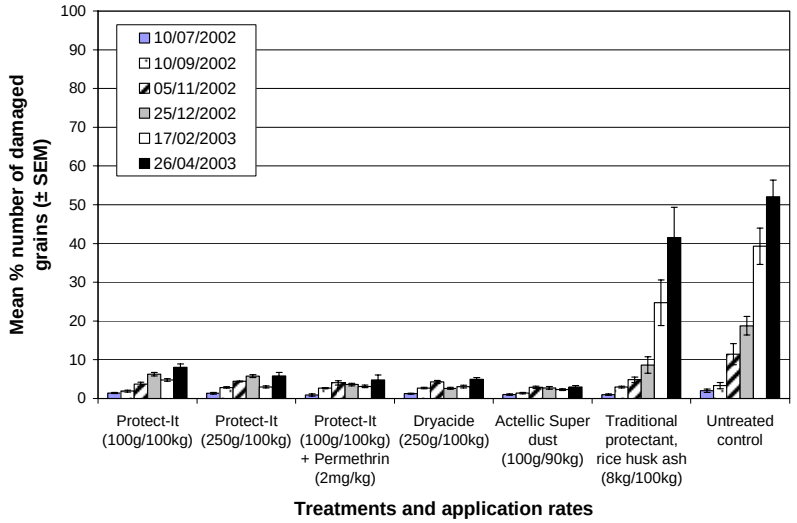


Figure 2c. Maize grain protection trial, Arri village, Babati district, Tanzania, 2002/2003

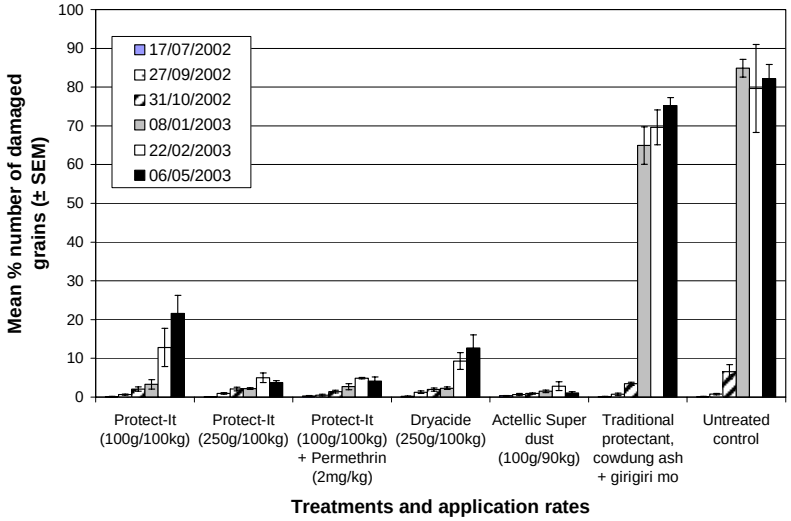


Figure 2d. Sorghum grain protection trial, Mwataga village, Kishapu district, Tanzania, 2002/2003

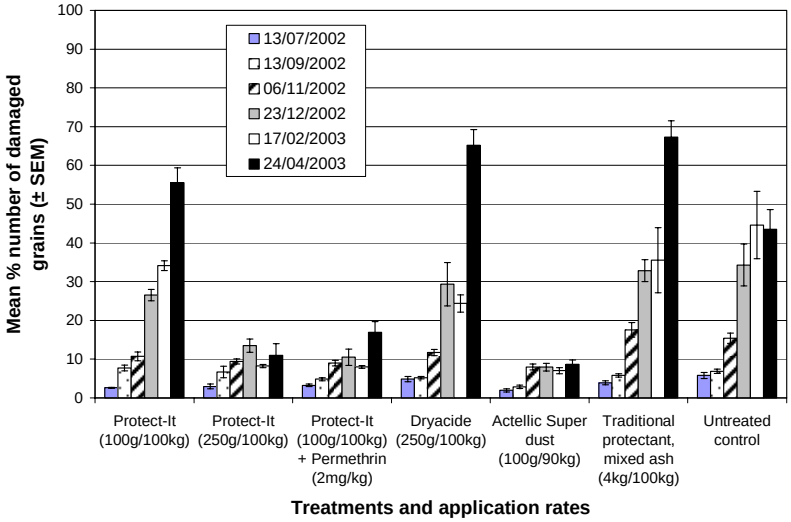


Figure 2e. Bean storage trial, Singe village, Babati district, Tanzania, 2002/2003

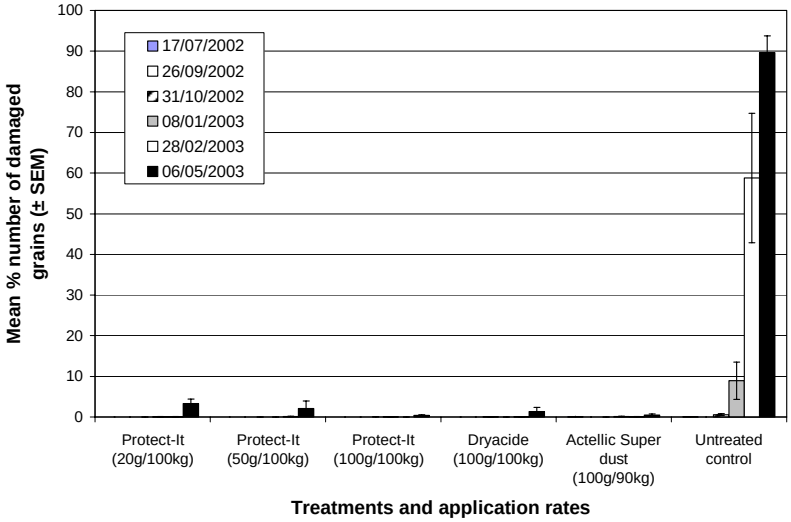


Figure 2f. Comparison of mean total number of adult insects/ kg per species on maize grain treated with different protectants during 2002/03 storage season at Mlali village.

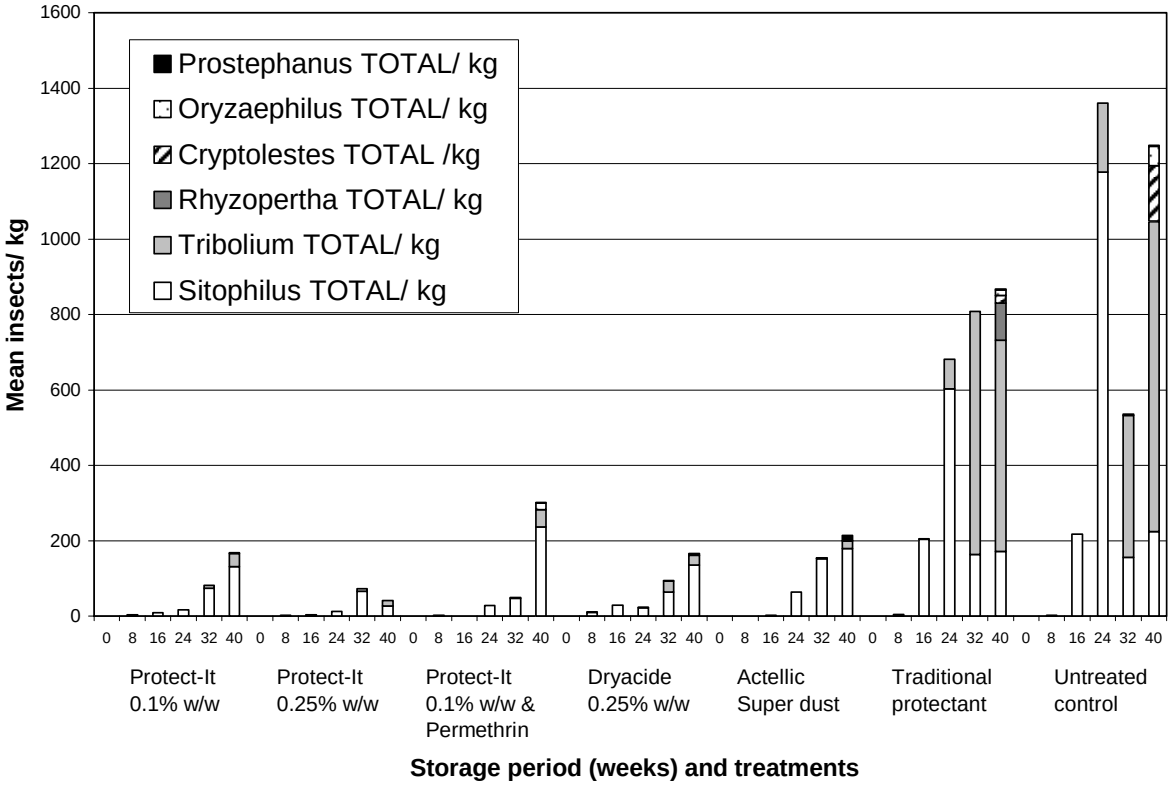


Figure 2g. Comparison of mean number of live adult insects/ kg per species on maize grain treated with different protectants during 2002/03 storage season at Mlali village.

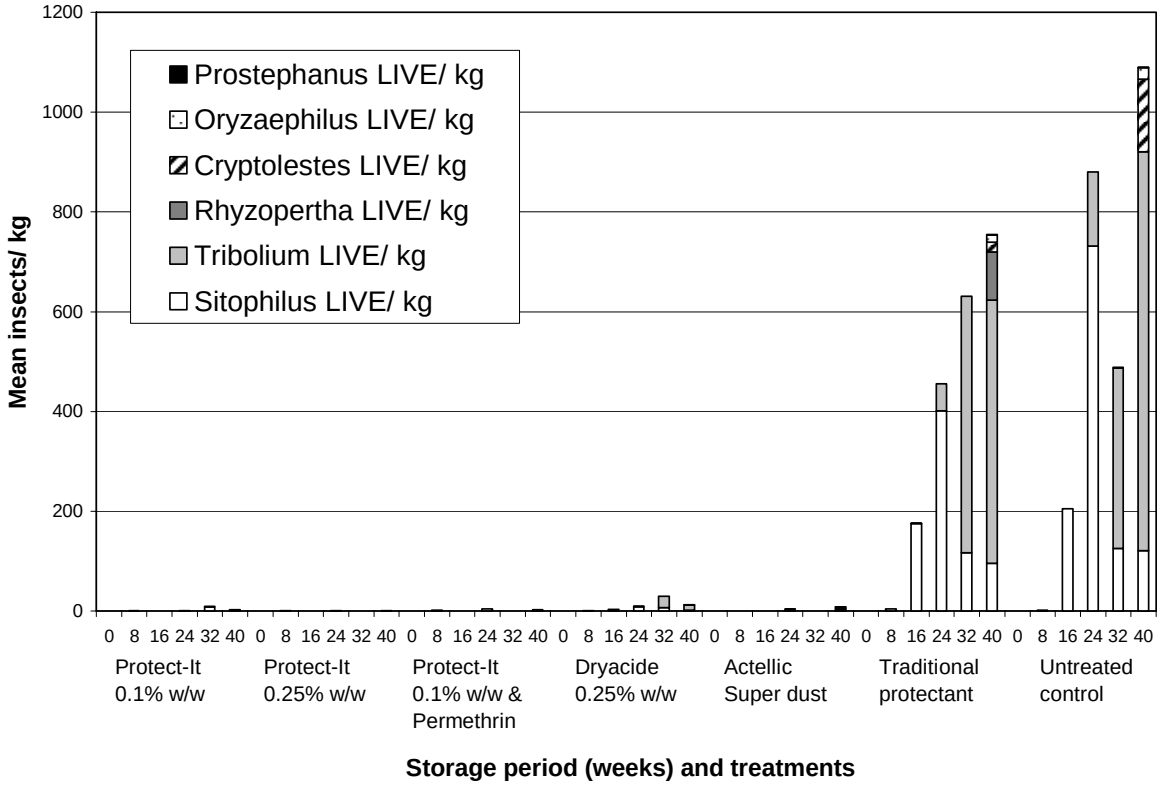


Figure 2h. Mean % in-vitro germination of whole maize grains treated with different protectants and stored for 40 weeks on-farm at Mlali village, Dodoma region, Tanzania, 2002/2003

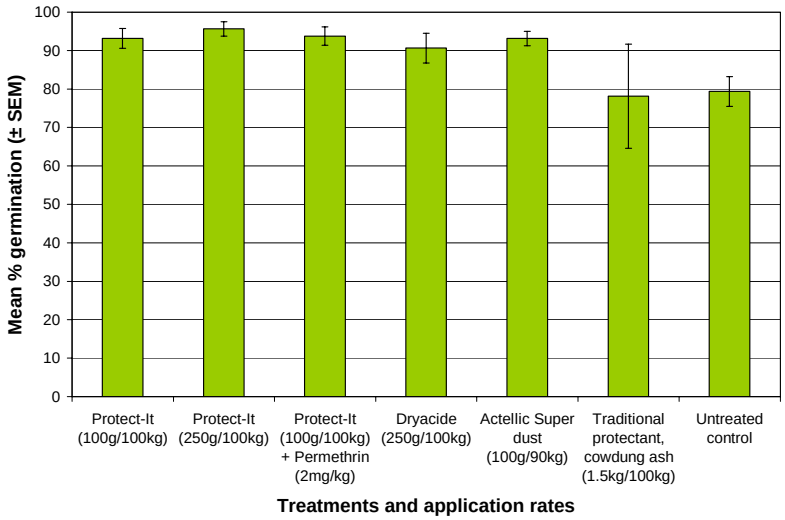


Figure 3a. Maize grain protection trial, Mlali village, Kongwa district, Tanzania, 2003/2004

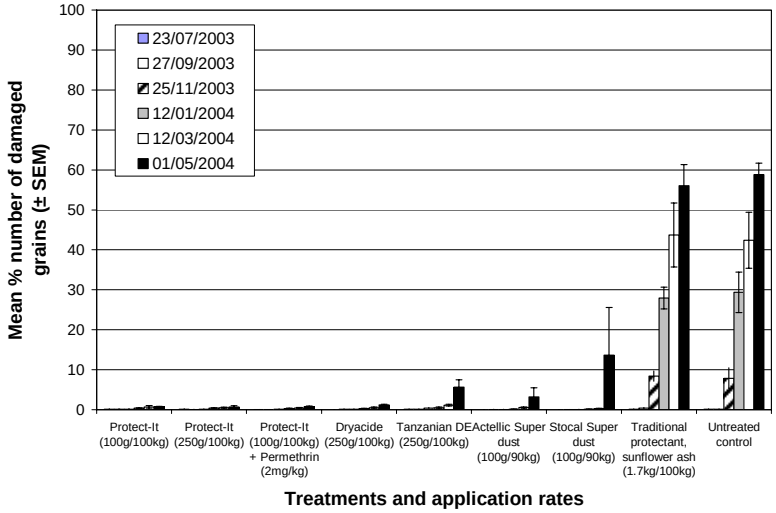


Figure 3b. Maize grain protection trial, Mwamakaranga village, Shinyanga district, Tanzania, 2003/2004

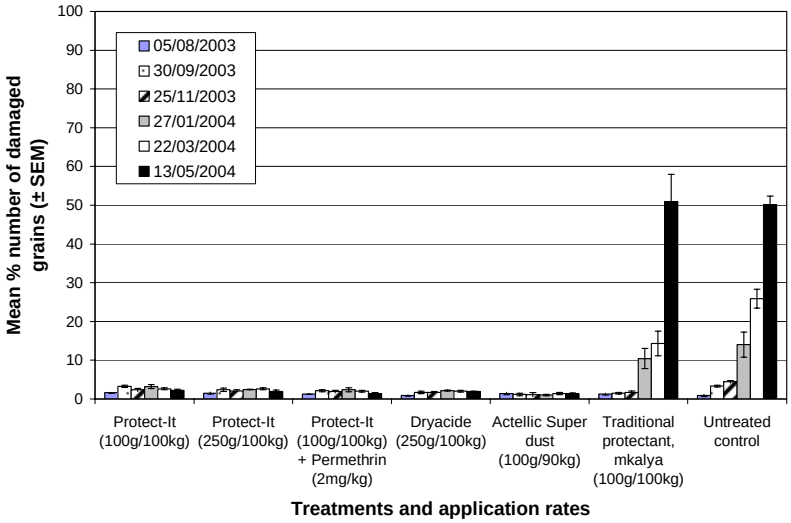


Figure 3c. Maize grain protection trial, Arri village, Babati district, Tanzania, 2003/2004

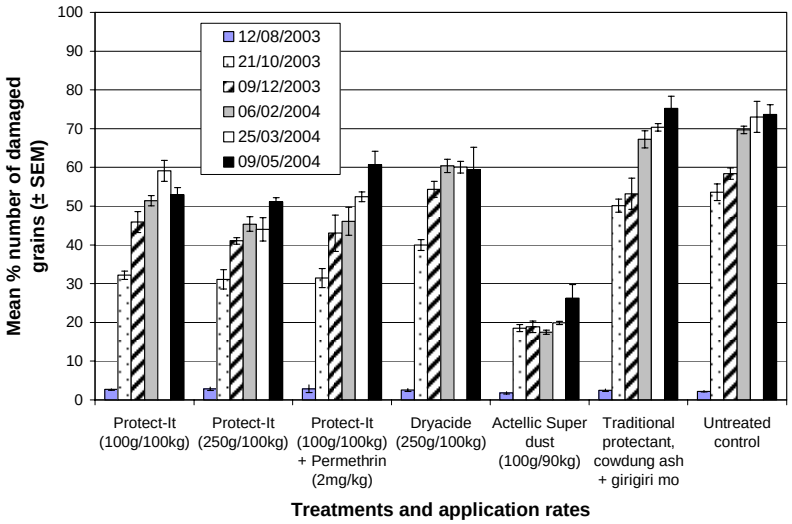


Figure 3d. Sorghum grain protection trial, Mwataga village, Kishapu district, Tanzania, 2003/04

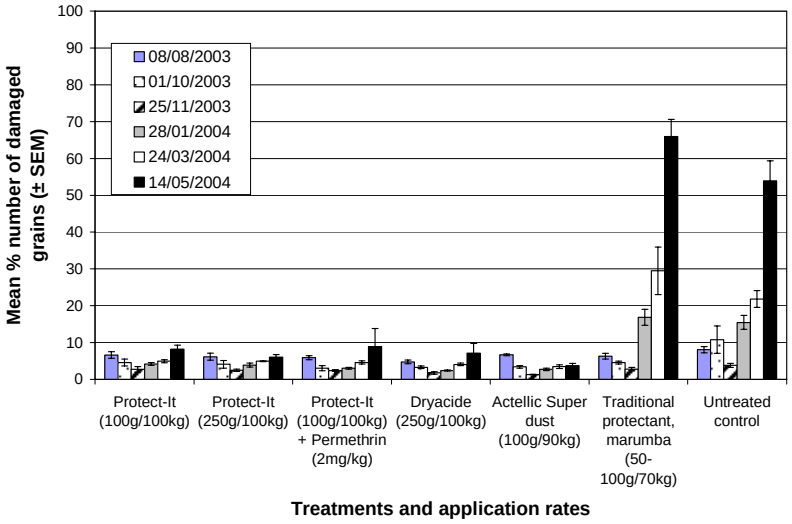


Figure 3e. Bean storage trial, Singe village, Babati district, Tanzania, 2003/04.

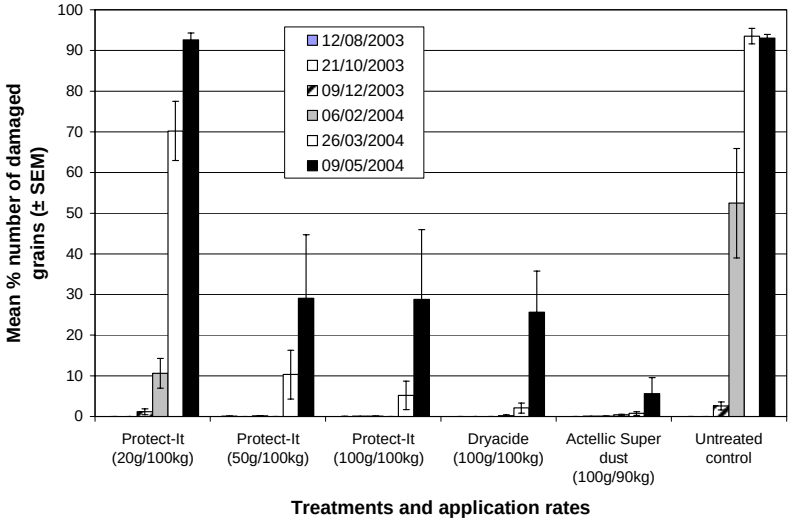


Figure 3f. Comparison of mean total number of adult insects/ kg per species on maize grain treated with different protectants during 2003/04 storage season at Mlali village.

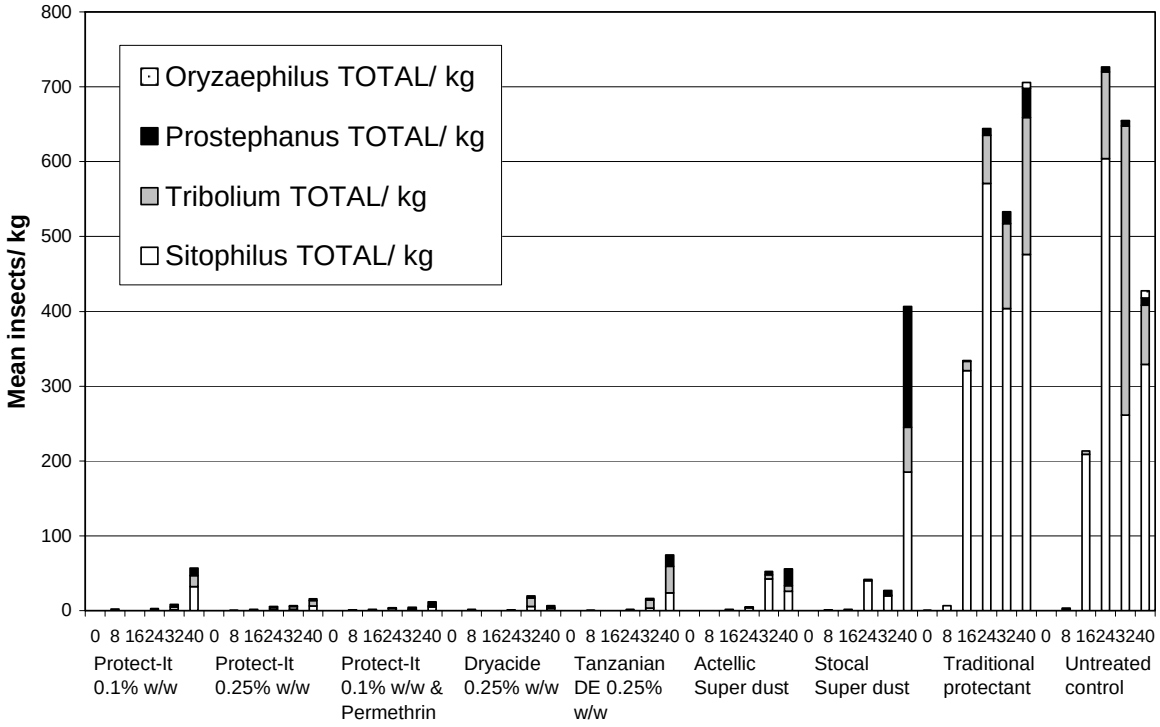


Figure 3g. Comparison of mean number of live adult insects/ kg per species on maize grain treated with different protectants during 2003/04 storage season at Mlali village.

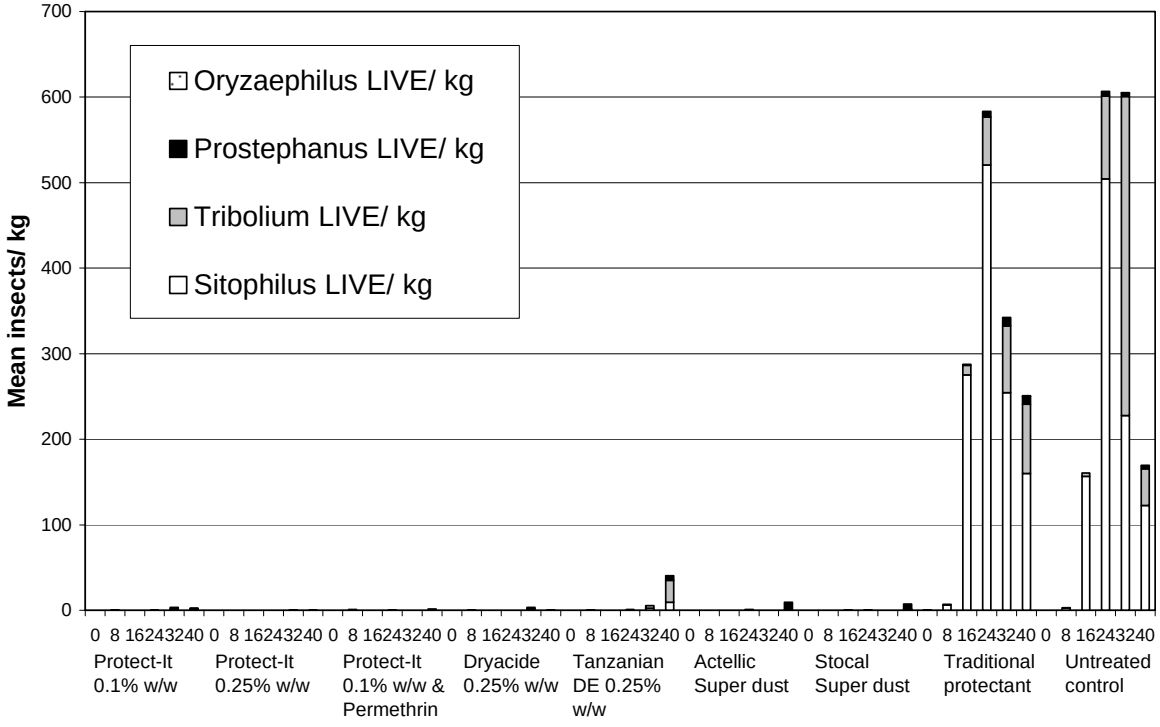


Figure 4a. Maize grain protection trial, Mlali village, Kongwa district, Tanzania, 2004/05

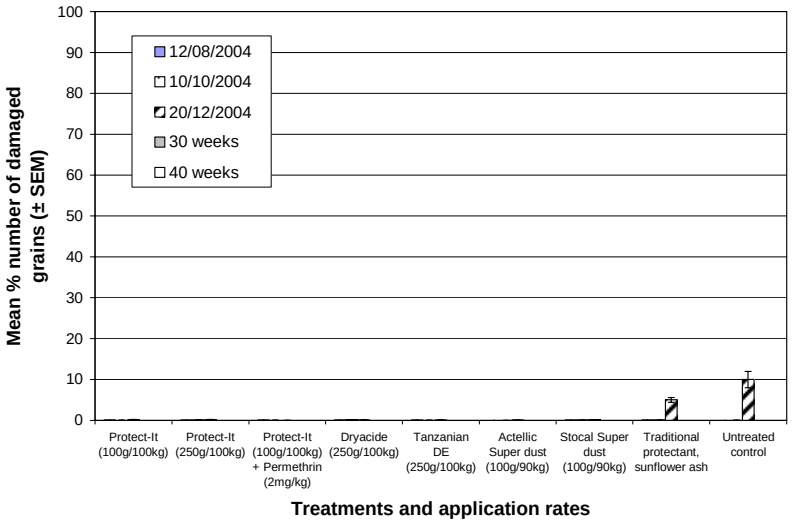
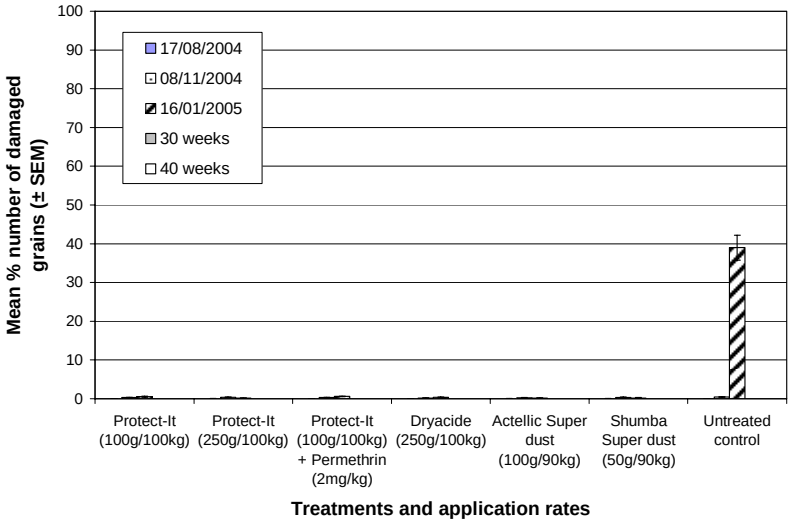


Figure 4b. Maize grain protection trial, Arri village, Babati district, Tanzania, 2004/05



Activity 1.2 Farmer evaluation of the different grain protection treatments trialled at the end of each storage season.

At the end of each storage season farmers purposively selected from different wealth groups were invited to come to one of a series of meetings in order to raise awareness about the findings of the storage trials that have often been housed only in a few farmers homes or had been in a central go-down position but not necessarily visited by a large variety of farmers. Separate meetings were held for the different wealth groups and in several locations wealth groups were also disaggregated by sex. During the meetings the farmers were asked to list what they used the stored grain for (e.g. food, sales, livestock feed, seed), and to rank these uses in terms of importance. They were then asked to list the criteria they used for assessing stored grain, and following this exercise to rank these criteria in terms of importance (see table 5 for details).

Table 5. Tanzanian farmers criteria for evaluating stored maize grain, sorghum and beans and their relative importance (ranked per column - 1 = most important), 2002/2004 storage season.

Stored grain	Maize										Sorghum			Beans				
Village	Mlali			Mwama-karanga			Arri				Mwataga			Singe				
Group No.	1	2	3	1	2	3	1	2	2	3	1	2	3	1	2	3	No. of times mentioned	Mean ranked position
Wealth status* (gender when separated)	M	H	L	H	L	M	H	MF	MM	L	H	M	L	H	M	L		
Criteria																		
No insect boring holes	1	1	2	1	2	1				1	1	1	1	1	1	2	13	1.2
No insects	6	3		4	1	3	3		6		2	5	2	4			11	3.5
No insect feeding dust	4	6	3				4		3								5	4
No *Prostephanus truncatus*	3		4														2	3.5
No weight loss due to insect feeding								4		5					6		3	5
No smell of insect damage								2		4							2	3
No sound of insect feeding	6																1	6
No damage to grain							1	1	1								3	1
Not rotten			1	3	3	2			2	2			4	2	2	1	10	2.2
No smell of mould	5			7							3	2					4	4.3
No dirt/ debris/ chaff	2	2		2	4	5	5	3	7	3							9	3.7
No dust											5		3	5		5	4	4.5
No unwinnowed sorghum									4			3					2	3.5
No small stones from threshing											4	4					2	4
No sign of rodent droppings or damage												6					1	6
No smell of unrecommended pesticide				5	5		2		3				5	6	4	3	8	4.1
No change in colour (i.e. resembles freshly harvested grain)	3	4	5	8		4									5		6	4.8
No unwinnowed/ unfilled beans														3	3	4	3	3.3
No shrinkage/ loss of weight due to premature harvesting		5		6	6												3	5.7

* L= Lower wealth households; M = Middle wealth households; H = Higher wealth households

Then using each of the criteria they had mentioned as important, they assessed code labelled samples of each of the different treatments and gave it a score (using a simple three point scale). At the end of the exercise the total score for each of the treatments was calculated, and the identity of the codes revealed and the efficacy of the treatments discussed (see table 6). At all sites the DE treatments scored highly as did the synthetic pesticide treatments. The traditional protectants and the untreated control were heavily damaged by insects and were always scored low compared to the other treatments. When we discussed with the groups why the traditional treatment had not been effective, and whether we had done something wrong during its application or management etc, the farmers responded that sometimes when the started to see insects they would winnow the grain and retreat it, but many said yes that is how damaged it gets when we do it, but we don't have any other options. The meetings provided farmers with the opportunity not only to see and feel first hand the comparative efficacy of a range of grain protectants, but also to discuss methods of application, expiry dates, recommendations for purchasing and timing of application and many other general grain storage issues. The private nature of grain storage which usually happens within kitchens, bedrooms or household storerooms means that farmers and other interested parties cannot easily see how effective each others practices are in the way they can with field crop or livestock practices, hence the sharing of grain storage information is very different from that of other agricultural information.

Mlali (LHS) and Mwamakaranga (RHS) farmers assessing grain samples following storage using different protectants

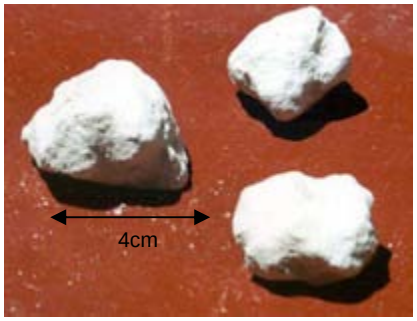
Table 6. Assessment of maize grain samples after 40 weeks storage with different grain protectants by a group of 14 men from lower wealth households in Mlali Iyegu and Mlali Bondeni villages, Dodoma region, Tanzania following the 2003/2004 storage season.

	Proportional score given to each criteria in terms of its importance when used as/ in		**Score given to each sample for each criteria** (3=very good, 2=not good, 1=very poor)											
			Researcher managed trial treatments									Farmers' names and the treatments they trialled		
												M. Mwaka		A. Mnyasi
Important criteria for evaluating stored maize grain *(Sifa)*	**FOOD/** *CHAKULA*	**SEED/** *MBEGU*	**Protect-It 0.1% w/w** (100g/ 100kg za mahindi)	**Protect-It 0.25% w/w** (250g/ 100kg za mahindi)	**Protect-It 0.1% & permethrin 2mg/kg**	**Actellic Super dust** (100g/ 90kg za mahindi)	**Dryacide 0.25% w/w** (250g/ 100kg za mahindi)	**Traditional protectant** *(Bila kupepeta na majivu)*	**Untreated control** (Bila chochote)	**Stocal Super dust** (100g/ 90kg za mahindi)	**Tanzanian DE** (250g/ 100kg za mahindi)	Protect-It (250g/ 100kg)	Actellic EC then ash	Protect-It (250g/ 100kg)
No insect boring *(Hayakutobolewa na wadudu)*	1	2	3	3	3	3	3	2	1	3	3	2	1	1
Well filled grain *(Yaliyokomaa - manene punje nzito, pendeza kwenye macho)*	4	1	3	3	3	3	3	3	2	3	3	3	1	3
No rotting *(Hayakuoza)*	2	3	3	3	3	3	3	3	3	2	3	3	3	3
Clean grain *(Safi hayana uchafu)*	3		3	3	3	3	3	2	1	3	3	3	1	3
No insects *(Hayana wadudu)*	2		3	3	3	2	3	2	3	3	3	3	1	3
Unmixed grain by colour *(Yasiyo na mchanganyiko wa rangi)*		6	3	3	3	2	3	3	3	3	3	3	3	3
Seed variety (*Aina ya mbegu*)		5	3	3	3	3	3	1	1	3	3	3	1	3
Large grains (*Punje nene*)		4	3	2	2	2	2	2	1	2	2	3	1	3
Unweighted totals:			24	23	23	21	23	18	15	22	23	23	12	22

Output 2: Several different African deposits of diatomaceous earth evaluated against storage insect pests, and assessed for their potential use as grain protectants.

Activity 2.1 At least two samples of local DEs located and collected in both Tanzania and Zimbabwe by Nov 2002.

DE samples were collected from: Kagera river basin and Singida, in Tanzania; Zambezi valley and Beitbridge in Zimbabwe; Zambia and South Africa.



Diatomite from Kagera river basin, Tanzania

Diatomite from Chemutsi, Zambezi valley, Zimbabwe

Sieving (100um aperture) of ground diatomite prior to drying to produce local DE

Activity 2.2 Laboratory efficacy trials of local DEs completed at University of Zimbabwe, NRI and Plant Protection Services (Tanzanian) by Oct 2003.

The diatomite rock samples collected were manually ground, sieved and dried prior to being used in the trials. Although initial laboratory trials conducted by Diatom Research and Consulting Inc. showed that all the African DE samples had low activity, further laboratory trials at NRI and UZ found that several of the samples reduced offspring emergence by up to 80% in comparison to untreated control grain when applied at rates of 0.25% w/w (see figs 5a &b).

Figure 5a. Laboratory comparison of the efficacy of raw African diatomaceous earths admixed with maize grain on adult mortality and F1 emergence of 50 14-28 day old *Sitophilus zeamais* at 27°C and 60% r.h, n=3, (NRI, UK, July 2003)

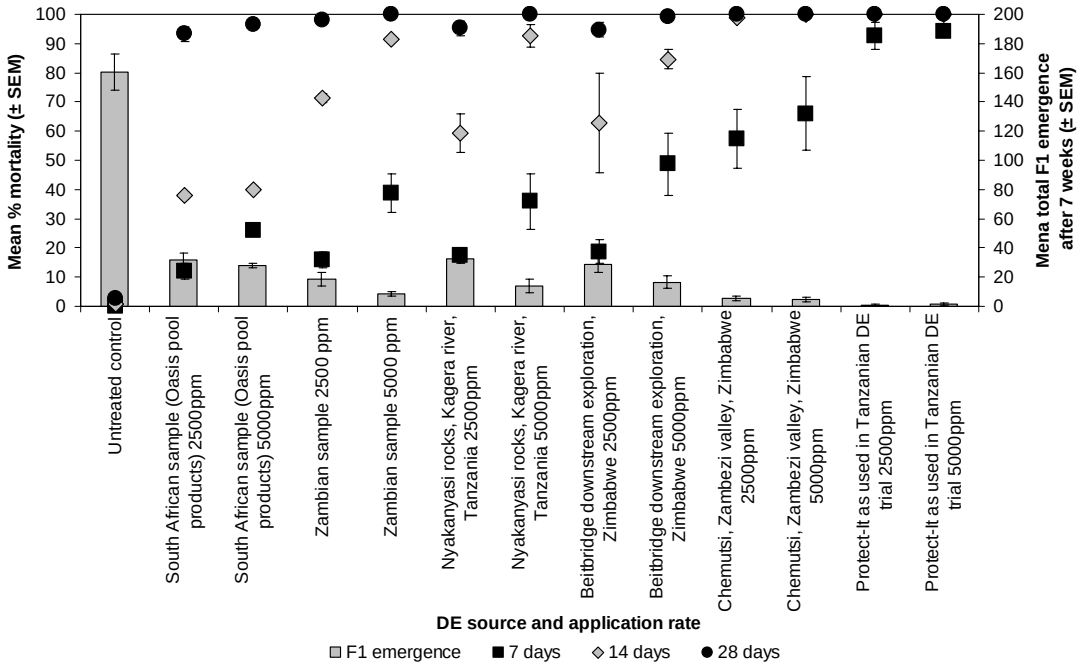
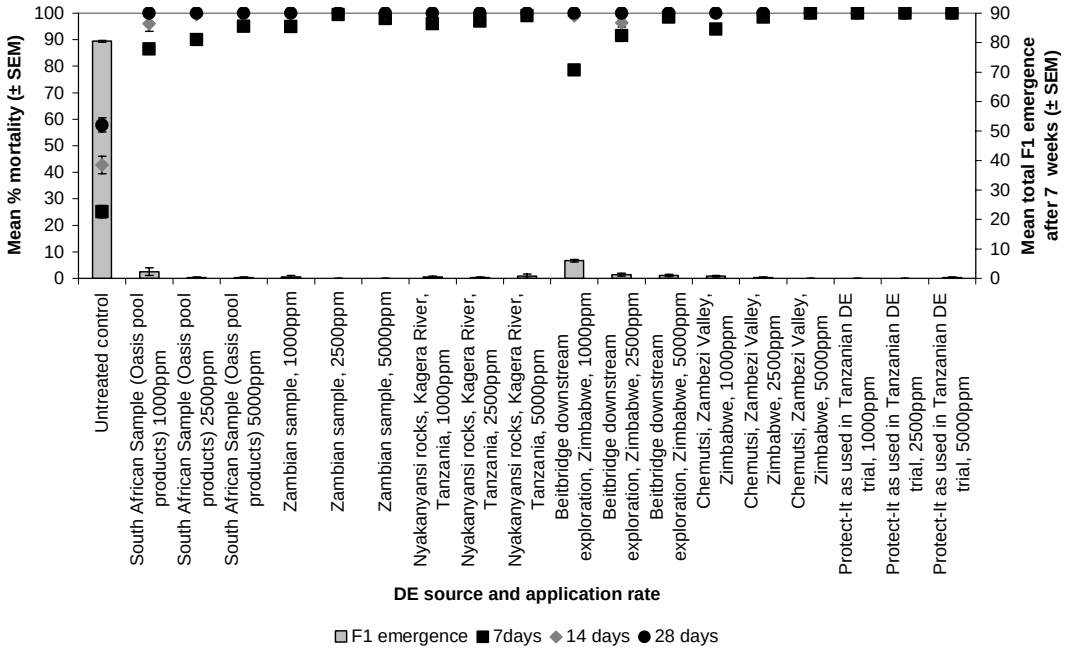


Figure 5b. Laboratory comparison of the efficacy of raw African diatomaceous earths admixed with maize grain on adult mortality and F1 emergence of 40 14-21 day old *Sitophilus zeamais*, at 27°C and 55% r.h., n=4 (UZ, Zimbabwe)



Activity 2.3 Most promising local DEs included in on-farm field trials in Tanzania and Zimbabwe from June 2003 - March 2004.

In Tanzania, the Kagera DE sample was included in the on-farm trials in Mlali village, Kongwa district in the 2003/04 and the 2004/05 storage season at 0.25% w/w (250g/100kg of grain). The Kagera DE successfully protected the stored maize against insect damage during a 10 month storage period in 2003/04 (see fig. 3a in activity 1.1 above), and appears to be equally as effective in 2004/05 (see fig. 4a) although we are only 6 months into the storage season at the time of writing this report.

In Zimbabwe a range of application rates of the Chemutsi (Zambezi valley) and Beitbridge DE samples were included in on-station and on-farm field trials in Buhera, Binga and Harare districts in the 2003/04 and the 2004/05 storage seasons. Improved traditional multi-compartmented stores made of brick walls and thatch grass roof were used at IAE and KMTC to store maize and sorghum respectively. However, in the latter, 50kg capacity polypropylene bags were actually used and placed in the working space within the structure as the compartments were being used by KMTC to store their own grain. In Buhera, 50kg polypropylene bags were also used but stored in four replicate farmers stores. Beans were similarly stored but in 10kg capacity polypropylene bags; especially made for the trials.

In the 2003/04 storage season, all the DEs were performed better than the untreated control over the 8-month storage period (see figs. 6a-d). The Zimbabwean DE was effective at ≥0.2%w/w and was as efficacious as Protect-It 0.1% and Actellic Super Dust 0.05%. Insect population increased rapidly as from week 24 in both the DE treatments and the untreated control. The grain moisture content reflects that environmental relative humidity did not constrain the efficacy of the DEs as it was still within acceptable limits for safe grain storage.

In the Buhera on-farm and IAE on-station trial set up at the start of the 2004/05 storage season, samples collected after 20 weeks showed that damage caused by insect attack was still ≤ 10% in both the raw and the commercial DE treatments compared to the untreated controls which had risen to 53% in cowpeas and 45% in maize (IAE). In the sorghum trial in Binga, no difference between treatments is yet evident. The traditional protectant of maize cob ash treatment on cowpeas has suffered damage similar to that of the untreated control. There is also evidence that damage in the finger millet chaff treatment has started increasing, however it is still lower than the untreated control. At present the insect population is dominated by *Sitophilus* species on maize and sorghum and the occurrence of *Rhyzopertha dominica* on sorghum is still patchy.

Figure 6a. Mean insect-damage (%) on maize grain treated with different concentrations of a local raw DE compared to imported DE or a synthetic insecticide, 2003/04 storage season at IAE, Harare (n=4)

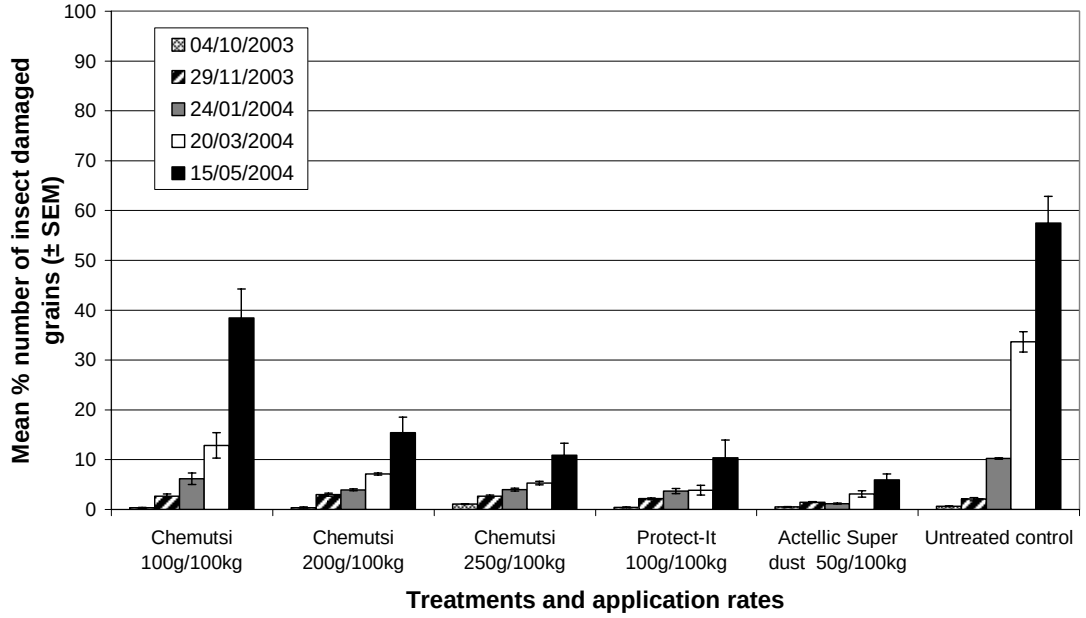


Figure 6b. Mean number of TOTAL adult insects/ kg per species on maize grain treated with different concentrations of a local raw DE compared to imported DE or a synthetic insecticide, 2003/04 storage season at IAE, Harare (n=4)

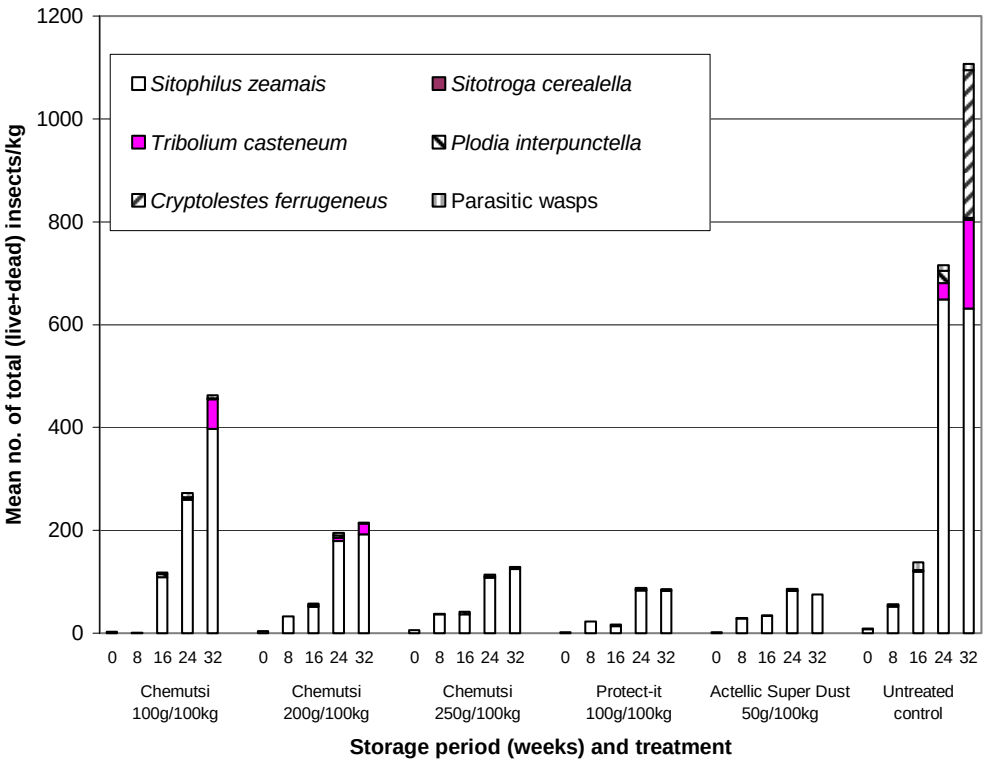


Figure 6c. Mean number of LIVE adult insects/ kg per species on maize grain treated with different concentrations of a local raw DE compared to imported DE or a synthetic insecticide, 2003/04 storage season at IAE, Harare (n=4)

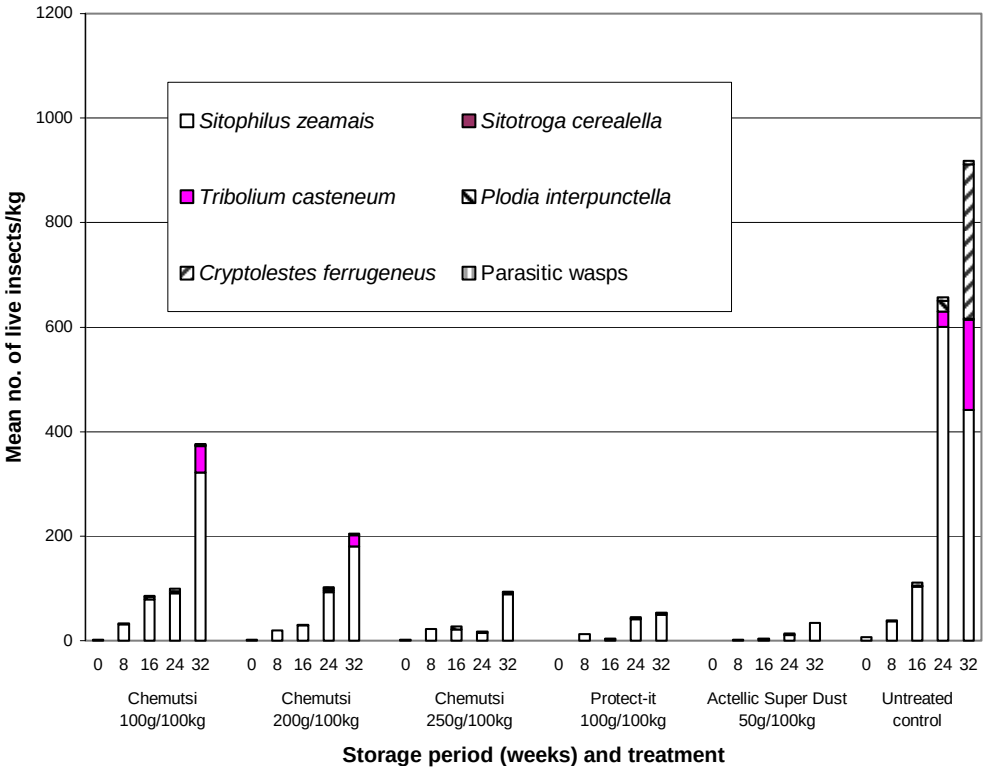
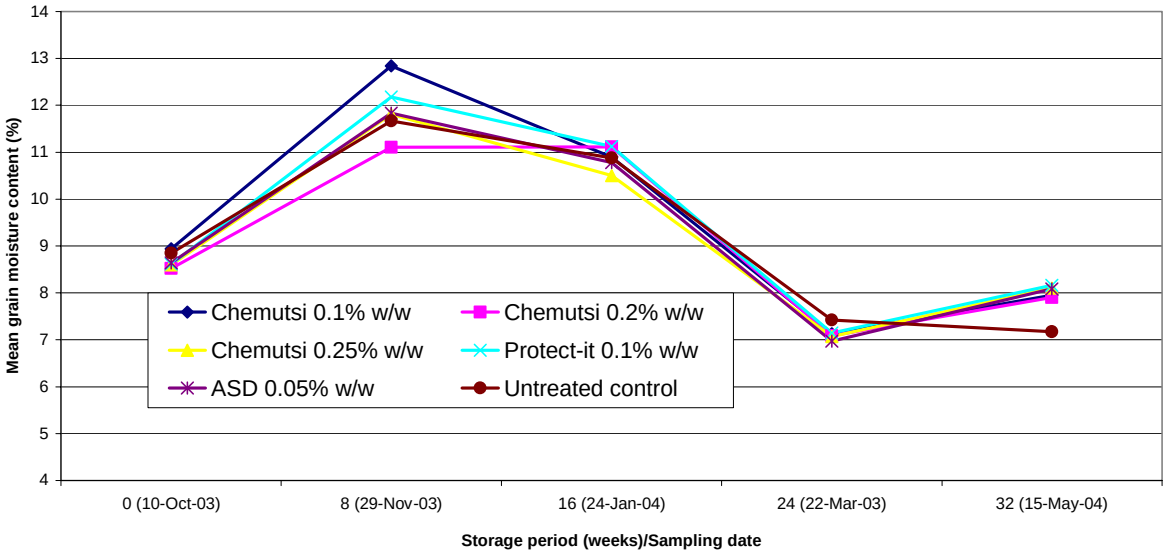


Figure 6d. Mean moisture content (%) of grain samples collected from IAE, Harare, 2003/2004 storage season (n=4)



Activity 2.4 Preliminary assessment of potential for exploitation and possible environmental impact of most promising local DE sources completed by Sept 2004.

The crystalline silica content of these African DEs is currently being analysed by a specialised laboratory as that has important health implications. If the crystalline silica content of the samples is acceptable, interested private sector companies plan to get involved in mining, processing and distributing these locally sourced grain protectants.

In Zimbabwe, Dorowa Mining Ltd has already started exploiting the Zambezi valley DE deposit for other industrial uses on an experimental basis and is keen to add a safe and effective grain protectant to its list of potential DE products. Their recent preliminary environmental impact assessment suggests that there are going to be hurdles in mining the Zambezi Valley DE deposit because it is located in a national game park and there is concern by Government that the mining activities will disrupt the wildlife ecosystem prevailing in the area. The company is considering focussing on the Beitbridge deposit, in the South of the country.

In Tanzania, an action plan to initiate this work was agreed during the planning meeting held in Dar es Salaam, June 2004. However it is still proving difficult to identify a local organisation with the relevant experience, following the results of the crystalline silica content analysis further efforts will be put into this activity if the crystalline silica content is shown to be safe to use as a grain protectant on food.

Contact with the project and the results of the NRI laboratory trials stimulated a private company in Zambia (Lusinde Investments Ltd) who had the mining rights for a DE deposit there to carry out further studies on the DE and develop and register it for use as an insecticide under the name of Diatocide. The registration is based solely on the findings of short-term laboratory bioassay studies as no field studies or environmental impact studies have yet been done.

Output 3: To develop a focused understanding of the factors which influence farmer decision-making with respect to grain storage technologies to better facilitate the uptake of DEs

Activity 3.1 Temporary registration of DEs as grain protectants in Zimbabwe successfully completed by April 2003.

Completed registration application forms for Protect-It and samples were submitted to EcoMark in September 2002 and to the Pesticide Registration Authority in March 2003. The current situation in Zimbabwe has led to extreme delay in processing the registration by the Pesticide Registration Authority (PRA) and Protect-It remains unregistered there at the time of writing. Meetings have been held between UZ, Ecomark and the registration authorities and Ecomark

(the registrant) was asked to repackage the technical publications into a simpler report for purposes of registration. The authorities verbally indicated that temporary registration was possible upon submission of the simplified version, however despite submission of the repackaged report temporary registration is yet to happen. In August 2003 David Zinyengere of EcoMark Ltd suggested it might be possible to quickly register Protect-It across the border in Zambia, despite the fact that only 1 year of data from an LGB infested region (Tanzania) had then been obtained. Ecomark Ltd still believes there is scope for pursuing this component despite the delay in implementation and preliminary exploration of this initiative in Zambia is scheduled for February 2005. Efforts to engage with the Pesticide Registration Authority staff have been difficult because of staff shortage and bureaucracy.

Activity 3.2 Participatory DE trials evaluating efficacy, cost, taste, cooking, brewing and application user acceptability completed by May 2004 in Zimbabwe.

Farmer managed trials (FMTs) were set up in Buhera District, Manicaland Province, Zimbabwe in both the 2003/04 and the 2004/05 storage seasons. Participating farmers were provided with a Protect-It DE sample sufficient to treat 2x50kg of maize which was paid for by the project. This treatment was compared with the farmers' normal practice using a similar amount of grain. Following meetings and demonstrations to explain the purpose of the trial, what DEs are, and how to apply them, the grain was treated and kept by the farmers themselves in their own stores. Materials used by the farmers to treat their own grain included ground goat droppings, finger millet chaff (residue left after threshing and winnowing), fresh Eucalyptus leaves, fresh Garcinia leaves, and maize cob ashes. However, the majority used Shumba Super Dust (Fenitrothion 1% + Deltamethrin 0.13%) which was commonly available in the local shops.

Periodic observation of the grain with the farmers followed by sampling at intervals of 12 weeks and laboratory analysis of the samples for insect damage and insect pest numbers showed that the current local or traditional grain methods were not efficient grain protectants. However, the synthetic insecticides were as effective as Protect-It (see graphs).

At farmer workshops organised by the District extension staff in collaboration with the project, following 36 weeks of storage, grain samples from the trial were blind-coded and evaluated by the farmers using their own criteria. The DE treatment was the most popular treatment and was highly ranked. Farmers demanded access to the protectant, so that they could buy it for themselves. However, as the product is still pending registration it cannot yet be availed.

One farmer described how the DE also killed cockroaches in the kitchen where they had done the admixing, and that high cockroach mortality continued to be observed for many weeks. DE-treated grain was also used as seed because it was still uninfested by storage insects. Most of the farmers who applied the traditional/local protectants had to re-winnow, expose the grain to the sun in thin layers and retreat after observing high levels of insect infestation. At least 6 farmers still had some of their DE-treated grain up to August 2004; they had kept it to find out if the DE protectant could work for a whole year.

Mr. Dumisani Moyo, an FMT farmer in Ward 5 of Buhera district, demonstrating proper admixing of DEs with maize to Buhera district agricultural extension staff attending a training workshop

Figure 7a. Farmer managed trial: Performance of Protect-It compared to other farmer grain protection practices, Buhera district, Zimbabwe, 2003/04 storage season

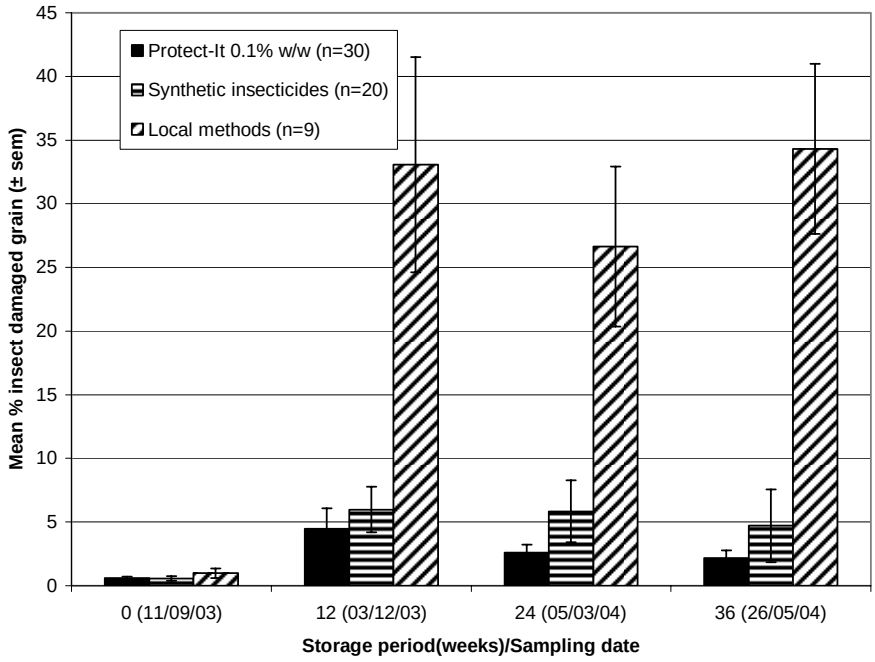
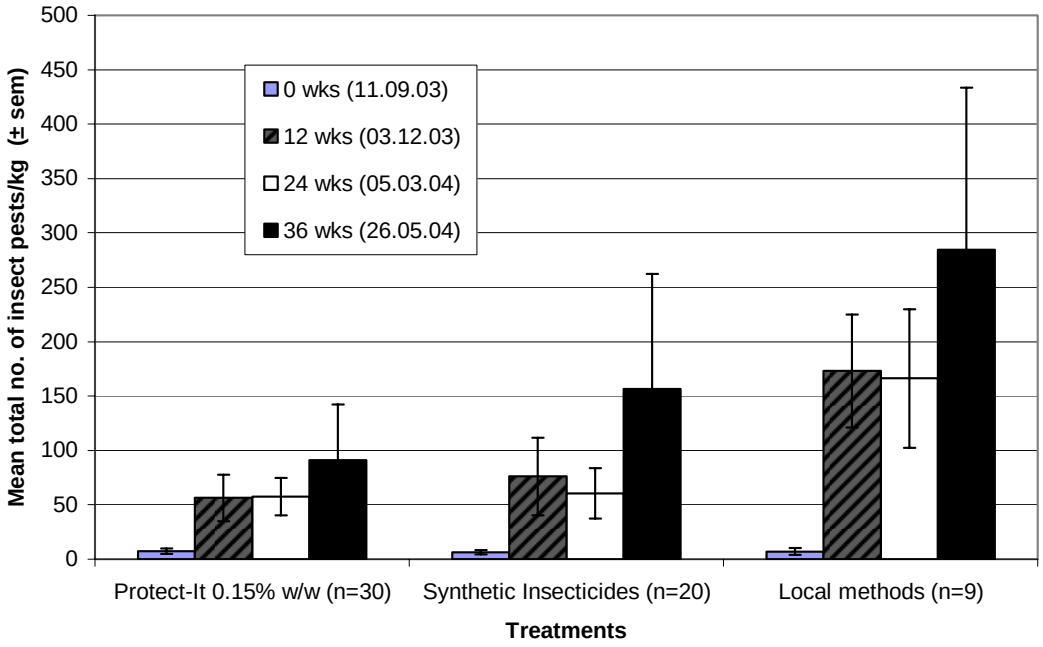


Figure 7b. Farmer managed trial: Suppression of storage insect pests using different farmer grain protection technologies compared to the DE technology, Buhera district, Zimbabwe 2003/04 storage season



In the current season (2004/2005), a similar trial was set up but more along the lines of the Tanzanian FMTs (see activity 3.4 for details). DE maize (1x50kg) still had to be bought because of ethical issues related to the fact the protectant is not yet registered and any use requires close supervision. The numbers of farmers in the 'poor' category as perceived by key informants in the community were increased to better understand farmer-decision processes in a diversity of households. The enquiry protocol is going to be used to capture this information.

In September 2004, a workshop was held to introduce Buhera district extension staff to the concepts and importance of encompassing farmer diversity in agricultural/technology interventions. The enquiry protocol (see activity 3.4 below for details) was highlighted as a tool that could be used to capture farmer diversity in the FMTs. It was generally observed that this

aspect had been missing in the routine extension approaches and the idea was well received. Plans were made for a representative of the Tanzanian team with experience in implementing the enquiry protocol, to visit Buhera and preside over the use of the tool there. The planned enquiry visits for December 2004 were cancelled due to study leave and to concentrate on the preparation of a CPHP PM whose submission dates were suddenly brought forward by two weeks (2 Dec instead of 15 Dec). Discussions are underway as to whether it is still possible to get input from the Tanzanian team within the remaining timeframe of the project.

Activity 3.3 Assessment of the registration requirements for use of DEs as grain protectants in Tanzania

In Tanzania, it has taken a significant length of time to discover just how the registration process works, and it has not been as straightforward as anticipated prior to the projects commencement. This is partially because the relevant laws do not explicitly define a procedure for registration of non-chemical plant protection substances, such as DEs. As a result processes to review the Plant Protection Act to this effect have been initiated and a registration procedure for non conventional pesticides has been proposed.

The roles of the Government organisation regarding pesticide registration are unusual in that the organisation responsible for registration (the Tropical Pesticides Research Institute (TPRI)) also normally commercially carries out the trials, which provide the data which is then submitted with the application. However, during the assessment of the first season's storage trials in May 2003 a researcher from TPRI was strategically brought into the DE project team. Two private agrochemical companies, Balton Tanzania Ltd and Twiga Chemicals got in touch with the project early on, following media reports about the success of DEs in the field trials. However they have not sustained their interest and as both are distributors of competitive products there is some concern. Contact with the Registrar of Pesticides at TPRI and with the Pesticide Approval and Registration Technical Subcommittee (PARTS) was made early on in the project, and they have received presentations about the use of diatomaceous earths as grain protectants and the results of the Tanzanian field trials. The PARTS committee then make recommendations to the National Plant Protection Advisory Committee (NPPAC), and at the recent NPPAC meeting, diatomaceous earths were discussed in great detail. There appears to be a lot of academic interest in the local DEs, although in reality it will be some time before these could be in a situation to be registered. According to the registration procedures of Tanzania, the imported commercial DEs Protect-It or Dryacide, could be instantly registered and distributed by an existing agro-chemical company in Tanzania on submission of a dossier (already drafted by the project) accompanied by the more than adequate field data generated by the project. The project team have decided to organise a promotional meeting in February 2004 to raise awareness about diatomaceous earths among the private sector and to hopefully attract in potential DE registrants. A press release from the MAFS has already been written and submitted to the permanent secretary. Contractual arrangements with the suppliers and shipping and import costs are being investigated by the project team in order to be able to supply the potential registrant with as much information as possible.

Activity 3.4 Farmer-managed DE trials assessing efficacy, cost and application acceptability in Tanzania completed by Mar 2004.

Farmer acceptability was originally to be assessed by encouraging and enabling a small number of farmers to trial the DEs on-farm themselves in the study villages. This was up-graded however when it became apparent that service providers had little or no systematic information on post harvest practices at the household level, or on the range of circumstances and factors influencing post harvest decision-making amongst diverse householders, and when the selection of criteria and farmer participants became fraught. Service providers not only had limited knowledge of farmer diversity and the factors influencing post-harvest decision-making, but were also without the 'tools' - possibly capacity and resources - to rectify this. A methodology was therefore developed to address this, and subsequently pre-tested and refined by the team. The wider aim (i.e. irrespective of the acceptability of DEs) was to mainline farmers in this and future research and provide service providers with the means to appreciate and respond to the diverse realities of farmers.

The enquiry protocol methodology has been successfully used in Kongwa and Babati districts in Tanzania since early 2004. While the protocol retains the concept of farmer managed trials this responsibility was delegated to village extension staff (VEOs) - *bwana shambas* –who

'extend' the DE technology to ~20 farmers in each village. Selected farmers from 'poorer' and 'middle' wealth-ranked households are provided with a 250g packet of Protect-it and instruction for its use in return for their participation in the 'enquiry' process. No other explicit incentives were offered and the farmers were left alone to follow (or not) the VEOs' instructions. The enquiry visits by the 'researchers', each involving dialogue with farmers guided by a set of prescribed questions, take place at intervals throughout the season - during harvest (July/Aug), early in the storage season (Oct/Nov), and later in the storage season (Jan/Feb) – to systematically explore post harvest - related activities and outcomes (e.g. harvest, storage practices, sales), livelihood status, and capture farmers' perceptions of the factors influencing these outcomes, and any relevant future plans. These findings, including the householders' experiences with the DE samples, are then 'triangulated' with those of the VEOs. Further analysis – the third and final enquiry visits have not yet taken place (Jan/ Feb) – will then be undertaken to develop a fuller understanding of factors influencing different households post harvest decision-making, based on the full time series.

Initial analysis (for Kongwa district) confirms that households identified by 'wealth-ranking' as belonging to the poorest section of the community (20%) have a poorer resource-base and engage in fewer livelihood strategies. Moreover, in the study year they produced insufficient surpluses to warrant treating, had fewer storage management options open to them, and were less likely or able to engage in strategic post harvest planning. There is greater divergence in the findings for farmers belonging to the 'middle wealth group' (60%), who generally appear significantly better resourced and able to take advantage of technologies such as DEs both for treating grain for household consumption, and realising better market prices as the storage season unfolds. The analysis is on-going as the final visit has not yet taken place.

Setting up an FMT in Mwamakaranga village

Farmer enquiry participants, Arri village

Esther, Mlali village compares her ash treatment (left) with her DE treatment (right)

Farmer enquiry interview, Arri village

Output 4: Extension materials describing DEs and their role and recommendations for use as a grain storage option by small-scale producers developed for the different information systems used by different groups of producers and disseminated

Activity 4.1 Identification of the different information systems used by different producer groups by Oct 2002.

Exploration of the respective information pathways of diverse end users was initiated using the 'enquiry protocol', and findings will shortly be triangulated/endorsed through focus group work.

An overview of the project's dissemination materials and their relevance to different stakeholders was prepared to identify information gaps, improve targeting and optimise communications with all project stakeholders.

Activity 4.2 Development of draft extension materials for the different information systems used by the different producer groups by Dec 2002.

Extension materials for intermediary agencies were developed in English, Kiswahili and Kisukuma by Dec. 2002. Demonstration protocols relating to the use of DEs (and other insecticide dust grain protectants, e.g. Actellic Super Dust) for treating stored grains were developed - photographed and filmed – and extension staff, farmers and others trained at all the trial locations. Individuals from the Tanzanian farmer education unit were actively involved in the research process. Extension officers and NGO staff from semi-arid areas of Tanzania and Zimbabwe have already been exposed to information about the use of DEs as potential alternative grain protectants to organo-phosphate based pesticides during IPM and MAFS post-harvest training courses or workshops.

However, despite all the work that the project has undertaken until a DE product is registered the non-research supervised use of DEs remains technically 'illegal'. This raises ethical dilemmas regards the production of extension material and premature 'promotion' of a product that is not yet available and for which the price remains uncertain. For these reasons, the sequencing of these activities was delayed – albeit plans to optimise extension and dissemination have been discussed and made at different levels with those responsible.

Mzee Magonde reading the kisukuma DE village noticeboard, Mwamakaranga village

Good grain storage management field day, Mlali village

Activity 4.3 Pre test extension materials during the setting up of participatory trials with at least 50 potential DE users in both Tanzania and Zimbabwe by Aug 2003. Develop and trial second draft by Feb 2004.

The research team have studied the village extension officer's collaboration with the farmers in the use of the DEs in the trial sites, in order to inform extension material development and to better understand the constraints and opportunities facing these service providers. The extension materials described in activity 4.2 above were developed, tested and reflected on and improved accordingly.

A glossy flier titled 'Farmers' livelihoods: What role for grain protection' was developed as an awareness raising material for the project team to be able to use with policy makers at different hierarchical levels, private sector companies, and donors. A copy of this flier will be available on the DE project website: http://www.nri.org/de/ . This flier will also serve to sensitise potential DE registrants.

Activity 4.4 Facilitate a grain storage management training workshop with 40 extension officers and 10 NGO or CBO staff from semi-arid areas of Tanzania and Zimbabwe aiming to ensure they understand the potential of DEs as one of a number of grain protectant strategies for small-scale producers by Mar 2005.

In Tanzania, the project is planning to use the funds for this activity to support additional attendance at the Ministry of Agriculture and Food Security's post-harvest training workshops planned to start in January 2005 as opposed to running separate project training workshops. As key facilitators in these training workshops, project team members will ensure that grain storage and the subject of diatomaceous earths are well covered and that individuals from relevant NGOs and project collaborators could also be supported to attend these training workshops.

In Zimbabwe, a similar approach will be adopted. The project is liaising with the Post-harvest Branch in Department of Agricultural Engineering and Technical Services and the Training Branch of Agricultural Research and Extension Services to provide an input (financially and technically) in the Post-harvest In-service Courses to be conducted in 2005.

During the project, those extension staff involved in the trials (Zimbabwe (6), Tanzania (12)) have received extensive hands-on training in the use and application of DEs as an integral component of grain storage management throughout the course of the project. Numerous visitors to the trials sites and participants in the projects workshops (NGO & CBO staff, exchange farmers, MPs, stockists, district administrative staff) have also received varying degrees of training on the use of diatomaceous earths as grain protectants.

Output 5: New knowledge promoted through newsletter (hard copy and www) articles, journal publications, conference presentations to alert workers in other countries, and end of project regional workshop (organised through SADC and/or ASARECA) to highlight benefits, describe methods etc.

Activity 5.1 Collect contact details of Tanzanian and Zimbabwean organisations interested in grain storage practices by Dec 2004.

Contact details of Tanzanian, Zimbabwean and global grain storage stakeholders have been collected throughout the project and entered into a database; those with electronic contact details have already received the project newsletter and information about the project website which contains a detailed summary of the project and copies of many of the projects disseminations.

Activity 5.2 Distribute 500 copies of written DE extension materials (see 4.2&4.3) within SADC countries by Feb 2005.

Extension materials in the form of project flyers, visual noticeboards, newsletters, a project website have all been widely disseminated within Tanzania and Zimbabwe. Wide media coverage about the projects activities has occurred in Tanzania. A glossy promotional leaflet has been developed for key policy influencers and private sector stakeholders. A list of the projects extensive disseminations is given in Appendix II of this report.

Visit the DE project website

www.nri.org/de/

Farmers enjoying the interactive DE project stand and discussions with the DE team (those in the white DE TShirts and caps) at nane nane (farmers day) Morogoro, Tanzania, 2004

Activity 5.3 Development and submission of two newsletter articles annually throughout the project lifecycle, and one journal article by May 2004.

A range of newsletter articles and three issues of a DE project newsletter were developed and published during the projects lifespan details are given in the appendix of this report. Three journal articles about different aspects of the project are at different stages of development: the laboratory and field efficacy of African DE deposits (Output 2); the successful Tanzanian DE field trials and farmer assessment of them (Output 1); the farmer decision making enquiry framework (Output 3). Three journal articles linked to the earlier DE research work have already been published.

Activity 5.4 Organise and facilitate end of project regional workshop by Mar 2005.

The project is currently planning to use these funds to add value to the post-harvest stakeholder workshop that the Tanzanian Post Harvest Management Services (PHMS) are organising. This will enable DEs to be mainlined in this workshop and will further raise awareness about their potential amongst a wide range of post-harvest stakeholders. We are hoping that we can influence the workshop organisers to also include regional participants.

Output 6: Project procedures evaluated throughout the project cycle, using participatory processes to capture different stakeholders' perspectives.

Activities 6.1, 6.2 & 6.3 Preparation, implementation and reporting on annual stakeholder evaluation of project progress and activities.

From an initial expectation, that all stakeholders be involved in participatory monitoring and evaluation, it became apparent from the different levels of activity and engagement (Figure 1), that for evaluation to be constructive it had to be linked to responsibilities and awareness of project objectives. Moreover, given the different arenas in which the project was working (e.g. conceptual, physical) it was unrealistic and impractical to host multi-stakeholder evaluations across the whole range of project activities. To address this issue a project team workshop was held in Babati, Tanzania in November 2003 to more formally explore PM&E of project processes. In particular constraints to and gaps in the communication processes between different players and between different levels were identified, solutions proposed, and indicators identified. These proposals were subsequently acted on.

In the context of the participatory development of the 'enquiry protocol' for Output 3, the team has minuted process, in written and photographic media. An external review of the project occurred in August 2003 which helped the team assess progress and develop the future workplans and processes. In June 2004 a participatory planning workshop held in Dar es Salaam and attended by team members from Tanzania, Zimbabwe and UK, and by staff from local, district, regional and national levels, provided the planning framework for all events in the 3rd year of the project. In 2004, the core team developed a written institutional history of the project which involved a lot of reflection.

Activity 6.4 Monitoring requirements of quarterly and annual reports submitted to CPHP throughout the project lifecycle.

All project monitoring reports have been written collaboratively by the core project team, through the electronic sharing and iteration of drafts.

Section F Project effectiveness

Small-scale farmer utilisation of diatomaceous earths during storage R8179	Rating
Project Goal: Poor people benefit from new knowledge applied to food commodity systems.	X
Project Purpose: The project's purpose is to develop and promote storage strategies that enable poorer people to increase the availability and improve the quality of their foods, leading to improved food security and reduced vulnerability.	2
Project Outputs 1. Methods for the protection of grain using commercially-available diatomaceous earths (DEs) against damage by P. truncatus and other storage insects optimised.	1
Project Output 2. Several different African deposits of diatomaceous earth evaluated against storage insect pests, and assessed for their potential use as grain protectants.	1
Project Output 3: To develop a focused understanding of the factors which influence farmer decision-making with respect to grain storage technologies to better facilitate the uptake of DEs	2
Project Output 4: Extension materials describing DEs and their role and recommendations for use as a grain storage option by small-scale producers developed for the different information systems used by different groups of producers and disseminated	3
Project Output 5: New knowledge promoted through newsletter (hard copy and www) articles, journal publications, conference presentations to alert workers in other countries, and end of project regional workshop (organised through SADC and/or ASARECA) to highlight benefits, describe methods etc.	2
Project Output 6: Project procedures evaluated throughout the project cycle, using participatory processes to capture different stakeholders' perspectives.	2

Rating key: 1= completely achieved; 2= largely achieved; 3= partially achieved; 4= achieved only to a very limited extent; X= too early to judge the extent of achievement (avoid using this rating for purpose and outputs)

Outputs

What were the research outputs achieved by the project as defined by the value of their respective OVIs? Were all the anticipated outputs achieved and if not what were the reasons?

Outputs:	**OVIs***:*	**Achievement of outputs against each OVI:**
1. Methods for the protection of grain using commercially-available diatomaceous earths (DEs) against damage by *P. truncatus* and other storage insects **optimised**.	1.1 First year on-farm field trials of DEs in 3 sites in Tanzania completed by June 2003. Second year on-farm field trials at same sites in Tanzania completed by June 2004.	1.1 First year on-farm DE field trials were successfully run in 5 sites[3] in 3 regions of Tanzania in the first and second storage seasons (2002/03 & 2003/04), these trials confirmed that DEs could protect maize, sorghum and beans for periods of 10 months storage in regions where *P. truncatus* was endemic. Higher concentrations of DEs were required to protect sorghum than maize because of damage by the bostrichid beetle *Rhyzopertha dominica*. During the second season the maize trial in Arri suffered high damage, this is thought to be due to the use of heavily infested grain at set up, the trial is being repeated for an additional third season (2004/05) to clarify this. An additional trial is also being run at Mlali village as the Tanzanian DE sample was so effective in the 2nd year that it was

[3] Mlali village, Kongwa district, Dodoma region (maize); Mwamakaranga village, Shinyanga district, Shinyanga region (maize); Mwataga village, Kishapu district, Shinyanga region (sorghum); Arri village, Babati district, Manyara region (maize); Singe village, Babati district, Manyara region (beans).

		felt worth repeating to substantiate the findings through two years worth of study..
2. Several different African deposits of diatomaceous earth **evaluated** against storage insect pests, and assessed for their potential use as grain protectants.	2.1 At least two samples of local DEs collected in both Tanzania and Zimbabwe by Nov 2002 (DE samples from other countries in the region will also be sourced and trialled during the project). 2.2 Laboratory efficacy trials (using standardised test protocol) of local DEs completed at University of Zimbabwe, NRI and Plant Protection Division and Diatom, by Oct 2003. 2.3 Crystalline silica content analysis of any promising local DEs completed by March 2004. 2.4 Most promising DEs included in on-farm field trials in Tanzania and Zimbabwe from June 2004 - March 2005. 2.5 Preliminary assessment of potential for exploitation and possible environmental impact of most promising local DE sources completed by Sept 2004.	2.1 Two samples of local DEs were located and collected in both Tanzania (Kagera and Singida (very impure) deposits) and Zimbabwe (Chemutsi and Beitbridge). Additional samples were also collected from Zambia and South Africa. 2.2 Laboratory efficacy trials were successfully completed by Diatom Research and Consulting and subsequently by NRI and University of Zimbabwe, it was seen as unnecessary for the Plant Health Services to repeat the laboratory trials in Tanzania. 2.3 This crystalline silica content analysis is currently underway (Jan 2005), this was delayed as it proved difficult to locate a laboratory able to conduct this analysis. LSM analytical services of UK will now be undertaking this analysis. 2.4 The Kagera DE sample (ground, dried and manually processed into a fine dust with particle size <100um) was used in the Tanzania on-farm field trials in Mlali village during the 2003/04 and 2004/05 storage seasons. Both the Chemutsi and Beitbridge DE samples have been included in field trials in Zimbabwe. These African DEs are proving to be very successful as long term grain protectants when applied at ≥0.2%w/w. 2.5 In Zimbabwe, Dorowa Minerals Ltd has undertaken an environmental impact assessment of the Zambezi valley DE deposit as they are already mining and using it for other industrial purposes on an experimental basis. As a result of hurdles in convincing the government about the environmental sustainability of DE mining in the Zambezi Valley, Dorowa Minerals Ltd are now shifting their attention to the Beitbridge deposit, in the South of the country and the company is yet to do an environmental impact assessment. Proper market studies have also not yet been done but the preliminary enquiries by other industrial users of DEs such as the paint industry, indicate that there is potential. In Tanzania it has proven difficult to identify local organisations with this expertise, and we are working with staff at the Ministry of Minerals and Energy on this.

3. User acceptability of diatomaceous earths in terms of efficacy, cost, application method, taste, cooking and brewing characteristics of DE treated stored grain **evaluated** In November 2003 we revised the wording for output 3 to read: **To develop a focused understanding of the factors which influence farmer decision-making with respect to grain storage technologies to better facilitate the uptake of DEs** This revised version will better inform post-harvest enquiry in general (and the associated processes have already been found useful by post-harvest management services), and avoids the potential/inherent dilemma in the earlier version, which failed to adequately convey that acceptability criteria will differ for different user groups, or the risk that farmers might innocently seek to confirm the research trial findings. Moreover, it presents a constructive outcome in place of impositions associated with delays in registration.	3.1a Temporary registration of DEs as grain protectants in Zimbabwe successfully completed by Apr 2003. 3.2a Participatory trials evaluating user acceptance of DEs in terms of efficacy, cost, taste, cooking, brewing and application acceptability completed by May 2004 in Zimbabwe. Farmer managed trials of DEs as grain protectants in terms of efficacy, cost and application acceptability in Tanzania completed by Mar 2004 (first season) and Mar 2005 (second season). (Note: user perspective of DEs on taste, brewing etc can not be assessed until DEs are formally registered in Tanzania & Zimbabwe.) 3.2b In line with the revised Output, an additional (or modified) OVI would be the participatory development of a methodology, based on farmer participatory and livelihood approaches, to explore the determinants of post-harvest decision making amongst diverse households. 3.3 Registration procedure of DEs as grain protectants by the Tropical Pesticide Research Institute in Arusha will be started in June 2002 and completed in September 2005.	3.1a The temporary registration of Protect-It in Zimbabwe is still awaited, documents were submitted to EcoMark the potential registrant in September 2002, and to the Pesticide Registration Authority in March 2003, but the situation in Zimbabwe has resulted in extreme delays, all the additional information the Pesticide Registration Authority has asked for has been submitted and it is hoped that a decision will be made shortly. 3.2a Farmer managed trials were set up in two seasons 2003/04 and 2004/05 in Zimbabwe and Tanzania. In the first season the trials were still heavily researcher influenced, in the second season the DE was handed over to the village extension officer who extended the technology to the farmers (from purposively selected poor & middle wealth households). The enquiry visits (see 3.2b below for details) are being used to collect information about farmers' perceptions of the progress of their trials and the whole process. To date however they have been highly impressed by the efficacy of Protect-It 0.1%w/w (Zw) and 0.1 and 0.25%w/w (Tz) and want to know when they will be able to purchase it. 3.2b A methodology to explore the factors influencing farmer PH decision-making, has been developed. Its design involved a large number of the core team, with a smaller number being involved in its pre-testing and refinement. To ensure that the findings are legitimate, the adopted method is in line with 'farmer participatory approaches'. It also encompasses wealth-ranking and elements of the sustainable livelihoods approach to facilitate analysis. Initial analysis suggest that DEs will be of direct benefit to households ranked locally as being in the 'middle' wealth/poverty group, but not directly for households in the 'lower' wealth/poverty group 3.3 Registration of DEs in Tanzania is much more complex than originally portrayed. TPRI have been brought into the project to help facilitate the registration. However the DE case has highlighted the need for adaptation of the current Plant Protection Act to encompass the registration of products with non-chemical modes of action. Three private sector companies have shown interest in registering Protect-It, a DE awareness raising meeting for private sector organisation is planned by the project in Feb 2005.

4. Extension materials describing DEs and their role and recommendations for use as a grain storage option by small-scale producers **developed** for the different information systems used by different groups of producers **and disseminated**	4.1 First draft of extension materials developed for the different information systems used by the different producer groups (women, non-literate etc.) including radio scripts, posters and leaflets (in Shona and Swahili) by Dec 2002. Pre-tested during the setting up of participatory trials (Jun-Aug 2003) with at least 50 potential DE users in both Tanzania and Zimbabwe. Second draft field-tested with 25 potential DE users in both Tanzania and Zimbabwe by Feb 2004. Comments incorporated into final version by Apr 2004. 4.2 40 extension officers and 10 NGO or CBO staff from semi-arid areas of Tanzania and Zimbabwe are satisfied with the grain storage management training workshop and understand the potential of DEs as one of a number of grain protectant strategies for small-scale producers by Mar 2005 in Zimbabwe and Tanzania.	4.1 A range of different extension materials (village noticeboards at trial sites in Kiswahili, Kisukuma and English, grain protectant admixing interactive village field days, grain protectant demonstration training protocols, television and radio programs, village cinema shows, interactive stands with demonstrations at agricultural shows, village meetings etc) have already been developed, pre tested and improved. However DEs are still not yet registered as grain protectants in Tanzania or Zimbabwe and therefore these various tools cannot be more widely tested or used yet. 4.2 It was decided that it was better to use these funds to support increased attendance at the Ministry of Agriculture planned post-harvest training workshops in early 2005, and for project staff to be key facilitators at these workshops to ensure that information about DE use is seen within its correct context of good grain storage management as opposed to as a separate unique subject. However, through their hands on involvement in the field trials and by attending updating and in-service training workshops >40 extension officers and >10 NGO/ CBO staff already understand and have experience of DEs as one of a number of grain protection strategies for small-scale producers.
5. New knowledge **promoted** through newsletter (hard copy and www) articles, journal publications, conference presentations to alert workers in other countries, and end of project regional workshop (organised through SADC and/or ASARECA) to highlight benefits, describe methods etc.	5.1 500 copies of written DE extension materials disseminated within both Tanzania and Zimbabwe by Feb 2005. 2 newsletter articles about the project findings submitted by December each year (2002-2005). At least one peer reviewed journal article submitted by May 2004. Individuals from 8 SADC countries are conversant with the projects findings and now have the capacity to include work on the use of DEs as an option for grain storage in their own countries in their workplans by Mar 2005.	5.1 >500 hard copies of a range of written DE extension materials (fliers, newsletters, reports) have been disseminated within both Tanzania and Zimbabwe. In addition electronic copies of the two issues of the projects newsletter were circulated to >200 global grain storage stakeholders through email. Articles for inclusion in other newsletters have been regularly submitted and published (see dissemination list in Annex for details). TV and radio programmes about the project work have been broadcast in Tanzania by interested independent media, the farmer education unit has also been involved in producing materials about the project. Presentations and papers about the projects' work have been made and submitted at a wide range of international and national conferences, workshops and seminars. Three articles are currently being prepared for journal publication. Three journal articles based on the findings of earlier DE work were published. Individuals from 6 SADC countries (Tanzania,

		Zimbabwe, Zambia, Uganda, South Africa, Kenya) are conversant with the projects findings and have either already included work on the use of DEs as an option for grain storage in their own countries in their workplans or have the capacity to do so. Further planned dissemination of the projects outputs in early 2005 will ensure that more regional grain storage stakeholders become conversant with DE technology.
6. Project procedures **evaluated** throughout the project cycle, using participatory processes to capture different stakeholders' perspectives.	6.1 The project is annually evaluated by all the different groups of stakeholders involved by March each year, and planned activities altered as necessary by May.	6. The project partners who represent a wide range of stakeholders have been involved in reflective feedback on and evaluation of the projects various activities and processes throughout the project.

Purpose

Based on the values of your purpose level OVIs, to what extent was the purpose achieved?

Purpose*:*	**OVIs**:	**Extent of achievement:**
This project will make a contribution to both CPH programme outputs 1 and 2 within the semi-arid production system, and may also have application within both the high potential and peri-urban production systems		
1. **Strategies developed which improve food security of poor households through increased availability and improved quality of foods AND**	1.1 By 2005, improved and sustainable on-farm pre-storage and storage systems validated for vulnerable maize, sorghum, millet and legume harvests of poor farmers.	1.1 With respect to DEs the 'storage' component of the OVI has been achieved in the trial locations. The trials to date have confirmed that DEs provide effective storage pest control for freshly harvested maize, sorghum and legume crops stored under 'similar' conditions to those experienced in rural households in the trial locations. Moreover farmer assessment of treated grains after 40 weeks storage was very positive. Use of the farmer (PH) enquiry tool together with the farmer managed trials activity are have provided information on the factors influencing the post-harvest decision- making of different types of households, and on their respective information networks
2. **Strategies to improve food security of poor households promoted**	2.1 By 2003, uptake pathways established for appropriate grain protection strategies	2.1 In Tanzania and to a lesser extent in Zimbabwe, the various intermediary agencies with existing responsibilities with existing responsibilities for providing the uptake pathways for grain protection strategies – mandatory and/or missionary - have been identified by type, many of those active in the trial locations have been co-opted into the project. The development of the enquiry framework – approach & tool – has already introduced a more critical awareness of poverty and HH food security issues amongst participating agencies, while the findings (the final enquiry visit has still to be completed and analysis is awaited) are expected to better facilitate promotional and

		dissemination strategies amongst agencies generally..
	2.2 By 2005, new knowledge adopted by target institutions (briefing of senior managers; confirmation that research outputs are compatible with target institutions' programmes; successful monitoring and evaluation of research outputs capability demonstrated by selected target institutions).	2.2 Information on DEs as a grain protection option is already being incorporated into training courses for extensionists, Min. of Ag. staff, NGO staff, farmers and tertiary level education students. The private sector is interested. The DE trials have been discussed by Tanzanian MPs in parliament as a response to the adulteration of Actellic Super dust.
	2.3 By 2005, end users in target countries aware of knowledge programme outputs.	2.3 Awareness raising information such as flyers, newsletters, training courses and a website have already been developed. In Tanzania there has been significant television, radio and newspaper coverage.

Goal

The project's outputs have already provided the following crucial links to the chain of realisation of the project's goal that poor people benefit from new knowledge applied to food commodity systems by:

- proving that DEs are effective in protecting on-farm stored grain for >10 months in areas where *P. truncatus* (LGB) is endemic;
- demonstrating that farmers can successfully use DEs as grain protectants and establishing that the demonstration group are both keen that DEs be made available locally and interested in purchasing them;
- establishing that local deposits of DE with insecticidal potential exist in sub-Saharan Africa, which therefore might provide the raw material for future storage protectant enterprises;
- confirming that the existing synthetic pesticides available are efficacious if applied properly (albeit not as safe for humans and the environment as DEs);
- developing a farmer enquiry tool for use in understanding factors influencing farmer post-harvest decision making and highlighting the diverse circumstances and post-harvest needs of different households and the importance for service providers to tailor recommendations to these different needs;
- highlighting the constraints within current post-harvest service provision
- establishing that some synthetic pesticides are being used inappropriately and with potentially harmful effect;
- raising awareness amongst farmers, extension staff, NGOs and ministry staff about good grain storage management principles, hygiene, early treatment, recommended protectants at recommended application rates, careful admixing, season long monitoring, simple comparison of different treatments; and
- raising awareness amongst key stakeholders about the efficacy of diatomaceous earths as grain protectants.

However, DEs still remain to be registered for use as grain protectants in both Tanzania or Zimbabwe and this is now a major bottleneck to any future activities. The registration processes have proved far more complex than was initially portrayed in Tanzania. In Zimbabwe, the economic instability, and associated loss of key staff, as well as the on-going agrarian reforms have all contributed to the serious delays in registration. The project is still actively involved in trying to facilitate these processes, but as registration (in Tz) requires a *bona fide* private sector operator to champion the registration process, there is a limit to what the research team can do.

Section G – Uptake and Impact

Organisational Uptake

What do you know about the uptake of research outputs by other intermediary institutions or projects? What uptake by which institutions/projects where?

Earlier work on DEs in Zimbabwe (R7034) which gave rise to this project, and also gave rise to an expression of interest from a Zambian research institute and stimulated DE trials by PPRI, South Africa with farmers in Limpopo Province, both of which have been able to follow the current project's progress via the website and newslettters. DEs were included in Uyole ARIs 2004/05 storage trials in the Southern Highlands of Tanzania. Ugandan researchers visited Tanzania to see the DE trials. The farmer enquiry methodology, has been utilised by PHMS and service providers (MoFA and NGOs) in Northern Ghana have shown interest. Agro-chemical companies in both Tanzania and Zimbabwe have shown a lot of interest in registering DEs, and a private Zambian company has registered a local DE as a grain protectant based on the projects initial stimulation.

End user uptake

What do you know about the uptake of research outputs by end-users?

Until DEs are registered only research use of DEs is legal. However, there is already huge demand by the farmers in all the trial sites in Tanzania and Zimbabwe, because of its efficacy in protecting grain over the last few seasons. Those end users most likely to utilise DEs are thought to be those who currently purchase commercial protectants, although many who currently use ashes or nothing at all have also shown interest particularly after seeing how long grain can remain without damage when protected. Figures on the market potential for DEs in Tanzania and Zimbabwe do not exist but could be obtained through extrapolation of data collected during the 1997 LGB coping strategies survey work in Tanzania. In Zimbabwe surveys carried out in the early 90s showed that ≥75% of small-scale farmers used synthetic insecticides for grain protection. Knowledge about grain protection in the trial villages has increased greatly as a result of interaction with team members and involvement in field days, the trials and assessment of the treatments [Farmer assessment workshops at the end of each seasons storage trials 2002/03 and 2003/04 in Tanzania were attended by 44 women & 92 men, and 174 men & 67 women respectively. Field days during the setting up of the researcher managed trials at all sites were attended by 101-1000 farmers. More farmers wanted to be involved in the farmer managed trials (FMT) than could be realistically managed at each site. Displays and samples of DE treated grain stored for >10 months attracted the interest of >1000 farmers' interest at the nane nane agricultural show].

Uptake of actual DE grain protectant as yet precluded by the absence of registration. However huge demand by trial site farmers, farmers at nane nane day, political demand (particularly due to serious problems with some of the synthetic pesticides), media publicity, the Minister made a statement at nane nane 2004 about needing to speed the trials up and get DEs out to farmers.

Knowledge

What do you know about the impact of the project on the stock of knowledge? What is the new knowledge? How significant is it? What is the evidence for this judgement?

DEs are effective in protecting stored grain from insect damage in storage environments in semi-arid locations in Tanzania and Zimbabwe and most likely in other sub Saharan African countries and further afield. Moreover DEs alone or in conjunction with pyrethroids can be used to protect grain against the ravages of LGB. This new knowledge, and the associated means of applying it, has potentially huge implications for household food security, welfare and even health considerations and is of national through to regional relevance. Initiation of the study of African DE deposits as grain protectants, and stimulation of interest among potential exploiters, has equally important implications for national economies. The enquiry methodology will provide PH knowledge managers with the means of generating a systematised picture of the circumstances and PH priorities of a diversity of households.

Institutional

What do you know about the impact on institutional capacity? What impact on which institutions and where? What change did it make to the organisations?

In Tanzania on-going 'rationalisation' has linked plant health services to 'production' and post-harvest services to 'food security'. This and accompanying staff changes blur and complicate impact assessment and the establishment of causation. In Zimbabwe the political situation has wrought similar outcomes. Changes to process: TPRI (Tz) has formally acknowledged that the project's findings will alone be sufficient to underpin registration, and MAFS now recognises the need to adapt the Plant Protection Act to accommodate products with non-chemical modes of action. The project has highlighted issues associated with decentralisation, household diversity and poverty, synthetic pesticide use, and ignorance generally about post harvest matters etc., and raised understanding of the associated institutional implications, and practice, amongst participating service providers.

Policy

What do you know about any impact on policy, law or regulations? What impact and where?

The project findings have been conveyed to a number of key players involved in policy formulation. In particular involvement of TPRI staff and their increased hands on awareness of storage pesticide issues affecting farmers. Increased demand for a review of the Plant Protection Act in Tanzania in order to accommodate non-synthetic chemical pesticides (including DEs). We understand that the appeal of the systematic approach to collecting post harvest information on farmers for PHMS, relates to its contribution to their 'evidence-based' approach to decision-making in policy formulation.

Poverty and livelihoods

What do you know about any impact on poverty or poor people and livelihoods?

For ethical reasons scaling-up can only take place once DEs are registered. Wealth-ranking exercises and use of the 'enquiry tool' have increased understanding of the complexity of rural livelihoods and poverty, and this new knowledge provides a better idea of the range of farmers for whom DEs might be relevant and affordable. The study itself directly helped families in the trial villages, training them in the correct use of grain protectants and providing them with the means to save food until the next harvest. New income opportunities as grain protectant application experts were generated for some of those farmers involved in setting up the research trials, and some measure of informal farmer group empowerment has taken place.

Environment

What do you know about any impact on the environment?

DE deposits in Kagera and Chemutsi have been field tested and shown to be effective, environmental impact assessments have not yet been done but preliminary investigations are underway. DE use is likely to diminish the synthetic pesticide use in storage of foods. Currently some farmers are using very dangerous products like livestock pesticides (Farmer Assessment, 2003) on their stored foods.

Signature Date: 31/1/2005

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ANNEXES

Annex I. Project Logical framework

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal			
Poor people benefit from new knowledge applied to food commodity systems.			
Purpose			
This project will make a contribution to both CPH programme outputs 1 and 2 within the semi-arid production system, and may also have application within both the high potential and peri-urban production systems.			Enabling environment exists for widespread adoption of new knowledge. Capacities of target institutions maintained at least at current levels. Food production constant or increasing.
1. Strategies developed which improve food security of poor households through increased availability and improved quality of foods. *AND*	1.1 By 2005, improved and sustainable on-farm pre-storage and storage systems validated for vulnerable maize, sorghum, millet and legume harvests of poor farmers.	1.1 Stakeholder evaluation reports of project. Target institution reports. Zonal PPD annual reports.	Political climate stable, no civil unrest.
2. **Strategies to improve food security of poor households promoted.**	2.1 By 2003, uptake pathways established for appropriate grain protection strategies 2.2 By 2005, new knowledge adopted by target institutions (briefing of senior managers; confirmation that research outputs are compatible with target institutions' programmes; successful monitoring and evaluation of research outputs capability demonstrated by selected target institutions). 2.3 By 2005, end users in target countries aware of knowledge programme outputs.	2.1 Feedback from target institutions, reports of their activities. 2.2 Target institution reports. 2.3 Stakeholder evaluation of project. Workplans of extension staff. Details of project information dissemination activity and feedback from them.	
Outputs			
1. Methods for the protection of grain using commercially-available diatomaceous earths (DEs) against damage by *P. truncatus* and other storage insects **optimised**.	*1.1* First year on-farm field trials of DEs in 2/3 sites in Tanzania completed by June 2003. Second year on-farm field trials at same sites in Tanzania completed by June 2004.	1.1 Inspection of: field trials, field data; and report. Interview with communities and target institutions involved in field trials.	Commercially available DEs are effective against the range of storage pests (including *P. truncatus*) under the field conditions found in the trial areas. Local DEs are effective

2. Several different African deposits of diatomaceous earth **evaluated** against storage insect pests, and assessed for their potential use as grain protectants.	2.1 At least two samples of local DEs collected in both Tanzania and Zimbabwe by Nov 2002 (DE samples from other countries in the region will also be sourced and trialled during the project).	2.1 Inspection of: the local samples of DEs.	against the range of storage pests, and have crystalline silica contents less than 1% preventing them from being classified as potential respiratory hazard and can therefore be recommended as suitable for admixture application by small-scale producers. The Zimbabwean and/or Tanzanian pesticide registration authority issues a temporary registration for the use of DEs as grain protectants. Political climate stable, no civil unrest. Local inflation and exchange rate remain stable enabling outputs to be achieved within the project budget. Skills and resources (credit/ financial, time, tools, organisational, labour) required to successfully effect treatment available to poor households or groups. Infrastructure and transport maintained at current levels. Adoption strategies have no deleterious implications at the intra-household level or with respect to gender.
	2.2 Laboratory efficacy trials (using standardised test protocol) of local DEs completed at University of Zimbabwe, NRI and Plant Protection Division and Diatom, by Oct 2003.	2.2 Inspection of laboratory data and report on the efficacy of the local DEs.	
	2.3 Crystalline silica content analysis of any promising local DEs completed by March 2004.	2.3 Inspection of crystalline silica content analysis reports.	
	2.4 Most promising DEs included in on-farm field trials in Tanzania and Zimbabwe from June 2004 - March 2005.	2.4 Inspection of field trials, data and report. Interview with communities and target institutions involved in the field trials.	
	2.5 Preliminary assessment of potential for exploitation and possible environmental impact of most promising local DE sources completed by Sept 2004.	2.5 Project report on 'Preliminary assessment of potential for exploitation and possible environmental impact of most promising local DE sources'.	
3. User acceptability of diatomaceous earths in terms of efficacy, cost, application method, taste, cooking and brewing characteristics of DE treated stored grain **evaluated** In November 2003 we revised the wording for output 3 to read: *To develop a focused understanding of the factors which influence farmer decision-making with respect to grain storage technologies to better facilitate the uptake of DEs*	3.1 Temporary registration of DEs as grain protectants in Zimbabwe successfully completed by Apr 2003.	3.1 Inspection of application form and certificate for temporary registration in Zimbabwe.	
	3.2 Participatory trials evaluating user acceptance of DEs in terms of efficacy, cost, taste, cooking, brewing and application acceptability completed by May 2004 in Zimbabwe. Farmer managed trials of DEs as grain protectants in terms of efficacy, cost and application acceptability in Tanzania completed by Mar 2004 (first season) and Mar 2005 (second season). (Note: user perspective of DEs on taste, brewing etc can not be assessed until DEs are formally registered in Tanzania & Zimbabwe.)	3.2 Interviews with households and target institutions involved in participatory DE user acceptance and farmer-managed trials. Inspection of trials, trial data and reports.	
	3.2b In line with the revised Output, an additional OVI was added: *The participatory development of a methodology, based on farmer participatory and livelihood approaches, to explore the determinants of post-*		

	harvest decision making amongst diverse households.			
	3.3a Registration procedure of DEs as grain protectants by the Tropical Products Research Institute in Arusha will be started in June 2002 and completed in September 2005.	3.3 Inspection of documents detailing commencement, progress and completion of DE registration procedure in Tanzania.		
4. Extension materials describing DEs and their role and recommendations for use as a grain storage option by small-scale producers **developed** for the different information systems used by different groups of producers *and disseminated* In November 2003 we revised the wording of Output 4: see italics above	4.1 First draft of extension materials developed for the different information systems used by the different producer groups (women, non-literate etc.) including radio scripts, posters and leaflets (in Shona and Swahili) by Dec 2002. Pre-tested during the setting up of participatory trials (Jun-Aug 2003) with at least 50 potential DE users in both Tanzania and Zimbabwe. Second draft field-tested with 25 potential DE users in both Tanzania and Zimbabwe by Feb 2004. Comments incorporated into final version by Apr 2004.	4.1 Inspection of 1st, 2nd and final drafts of extension materials, and the comments made about them by test producer groups.		
	4.2 40 extension officers and 10 NGO or CBO staff from semi-arid areas of Tanzania and Zimbabwe are satisfied with the grain storage management training workshop and understand the potential of DEs as one of a number of grain protectant strategies for small-scale producers by Mar 2005 in Zimbabwe and Tanzania.	4.2 Evaluation report of grain storage management workshop by participants.		
5. New knowledge **disseminated** and **promoted** through newsletter (hard copy and www) articles, journal publications, conference presentations to alert workers in other countries, and end of project regional workshop (organised through SADC and/or ASARECA) to highlight benefits, describe methods etc. In November 2003 we revised the wording of Output 5: *New knowledge promoted through newsletter (hard copy and www) articles, journal publications, conference presentations to alert workers in other countries, and end of project regional workshop*	4.1 500 copies of written DE extension materials disseminated within both Tanzania and Zimbabwe by Feb 2005. 2 newsletter articles about the project findings submitted by December each year (2002-2005). At least one peer reviewed journal article submitted by May 2004. Individuals from 8 SADC countries are conversant with the projects findings and now have the capacity to include work on the use of DEs as an option for grain storage in their own countries in their workplans by Mar 2005.	5.1 Inspection of: list of recipients of the 500 copies of the DE extension materials; draft and final newsletter and journal publications; evaluation report of the regional workshop by participants including details of inclusion of work on DEs in their own countries workplans.		

(organised through SADC and/or ASARECA) to highlight benefits, describe methods etc.			
6. Project procedures **evaluated** throughout the project cycle, using participatory processes to capture different stakeholders' perspectives.	6.1 The project is annually evaluated by all the different groups of stakeholders involved by March each year, and planned activities altered as necessary by May.	6.1 Inspection of annual project stakeholder evaluation reports; and details of effected changes.	
Activities			
1.1 On-farm field trials of commercially available DEs alone and in combination with very low doses of pyrethroids against *P. truncatus* damage in comparison with traditional grain protection methods in two sites in Tanzania over two storage seasons (2002/3 & 2003/4).			No key project staff changes within the collaborating institutions during the project.
1.2 Farmer evaluation of the different grain protection treatments trialled at the end of each storage season.			
2.1 At least two samples of local DEs located and collected in both Tanzania and Zimbabwe by Nov 2002.			Local DE samples are obtainable.
2.2 Laboratory efficacy trials of local DEs completed at University of Zimbabwe, NRI and Plant Protection Services (Tanzanian) by Oct 2003.			
2.3 Most promising local DEs included in on-farm field trials in Tanzania and Zimbabwe from June 2003 - March 2004.			
2.4 Preliminary assessment of potential for exploitation and possible environmental impact of most promising local DE sources completed by Sept 2004.			
3.1 Temporary registration of DEs as grain protectants in Zimbabwe successfully completed by April 2003.			DEs are successfully registered.

3.2 Participatory DE trials evaluating efficacy, cost, taste, cooking, brewing and application user acceptability completed by May 2004 in Zimbabwe. 3.3 Assessment of the registration requirements for use of DEs as grain protectants in Tanzania 3.4 Farmer-managed DE trials assessing efficacy, cost and application acceptability in Tanzania completed by Mar 2004. 4.1 Identification of the different information systems used by different producer groups by Oct 2002. 4.2 Development of draft extension materials for the different information systems used by the different producer groups by Dec 2002. 4.3 Pre test extension materials during the setting up of participatory trials with at least 50 potential DE users in both Tanzania and Zimbabwe by Aug 2003. Develop and trial second draft by Feb 2004. 4.4 Facilitate a grain storage management training workshop with 40 extension officers and 10 NGO or CBO staff from semi-arid areas of Tanzania and Zimbabwe aiming to ensure they understand the potential of DEs as one of a number of grain protectant strategies for small-scale producers by Mar 2005. 5.1 Collect contact details of Tanzanian and Zimbabwean organisations interested in grain storage practices by Dec 2004. 5.2 Distribute 500 copies of written DE extension materials (see 4.2&4.3) within SADC countries by Feb 2005.			Farmers are keen to participate.	

5.3 Development and submission of two newsletter articles annually throughout the project lifecycle, and one journal article by May 2004. 5.4 Organise and facilitate end of project regional workshop by Mar 2005. 6.1 Preparation of stakeholder evaluation procedures by Jan 2003. 6.2 Annual participatory evaluation of project progress and activities by Apr each year. 6.3 Report writing on project stakeholder evaluation by May each year. 6.4 Monitoring requirements of quarterly and annual reports submitted to CPHP throughout the project lifecycle.			

Annex II. Project R8179 disseminated outputs

Publications

FIELDS, P., ALLEN, S., KORUNIC, Z., McLAUGHLIN, A., and STATHERS, T. (2003) Standardised testing for diatomaceous earth. pp 779-784. In: *Advances in Stored Product Protection: Proceedings of the 8th International Working Conference on Stored Product Protection*, *York, UK. 22-26 July 2002*. Credland, P. F., Armitage, D. M., Bell, C. H., Cogan, P. M. and Highley, E. (Eds). CABI Publishing, Wallingford, UK.

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MAUNGA, N. (2004) Insects have affected food security, says UK scientist. *The Post*, 13 October 2004, p. 5. [Newspaper article] [Zambia]

MVUMI, B. M., GOLOB P., STATHERS, T. E. and GIGA, D. P. (2003) Insect population dynamics and grain damage in small-farm stores in Zimbabwe with particular reference to *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae). pp151-168. In: *Advances in Stored Product Protection: Proceedings of the 8th International Working Conference on Stored Product Protection, York, UK. 22-26 July 2002*. Credland, P. F., Armitage, D. M., Bell, C. H., Cogan, P. M. and Highley, E. (Eds). CABI Publishing, Wallingford, UK.

MVUMI, B.M. and STATHERS, T. E. (2003) Diatomaceous earths as grain protectants in sub-Saharan Africa. *Post-Harvest Bulletin*, **6** (2): 4-5. [Article reproduced in *The New Farmer*, November 2003, Zimbabwe].

MVUMI, B.M. and STATHERS, T.E. (submitted) Challenges of grain protection in sub-Saharan Africa: the case of diatomaceous earths. 6 pp. In: *Food Africa: Proceedings of the Food Africa Internet based Forum, 31 March - 11 April 2003.* Abstract available on the website: <http://foodafrica.nri.org>.

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STATHERS, T. E. (2003) Combinations to enhance the efficacy of diatomaceous earths against the larger grain borer, *Prostephanus truncatus* (Horn). pp 925-929. In: *Advances in Stored Product Protection: Proceedings of the 8th International Working Conference on Stored Product Protection, York, UK. 22-26 July 2002.* Credland, P. F., Armitage, D. M., Bell, C. H., Cogan, P. M. and Highley, E. (Eds). CABI Publishing, Wallingford, UK.

STATHERS, T.E., CHIGARIRO, J., MUDIWA, M., MVUMI, B.M. and GOLOB, P. (2002) Small-scale farmer perceptions of diatomaceous earth products as potential stored grain protectants in Zimbabwe. *Crop Protection*, **21** (10): 1049-1060.

STATHERS, T. E., DENNIFF, M. and GOLOB, P. (2002) The efficacy and persistence of diatomaceous earths admixed with commodity against four tropical stored grain beetles. *Journal of Stored Products Research*, **40**: 113-123.

STATHERS, T.E., MVUMI, B.M. and GOLOB, P. (2002) Field assessment of the efficacy and persistence of diatomaceous earths in protecting stored grain on small-scale farms in Zimbabwe. *Crop Protection*, **21** (10): 1033-1048.

STATHERS, T.E., RIWA, W. and MVUMI, B.M. (2003) Could fossil dusts be an option for increasing food security in sub-Saharan Africa? *PhAction News*, **6**: 20-21. Available on PhAction website: <http://www.foodnet.cgiar.org/PhAction/newslet.htm>

Additional publications are in preparation.

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KORUNIC, Z. (2003) Potential insecticide efficacy of Africa's diatomaceous earths. Diatom Research and Consulting Inc., Guelph, Ontario, Canada. 12 pp.

MORRIS, M. (2002) Back to Office Report of Visit Number 9365: Project site visits for the 'Small-scale farmer utilisation of diatomaceous earths during storage' project, A1051, R8179. 27 October - 12 November 2002. Natural Resources Institute (NRI), Chatham, UK. 3 pp.

MORRIS, M. (2003) Participatory evaluation: Discussion of key issues and the way ahead? Discussion paper. Natural Resources Institute (NRI), Chatham, UK. 8 pp.

MORRIS, M. (2003) Participatory monitoring and evaluation (PM&E) plan and framework. Discussion paper. Natural Resources Institute (NRI), Chatham, UK. 6 pp.

MORRIS, M. (2003) Methodology for engaging farmers. Discussion paper. Natural Resources Institute (NRI), Chatham, UK. 5 pp.

MORRIS, M. (2003) Recognising farmer diversity, mainlining and optimising their different inputs. Discussion paper. Natural Resources Institute (NRI), Chatham, UK. 3 pp.

MORRIS, M. (2003) Back to Office Report of Visit Number 9827: Visit to project locations in Shinyanga and Manyara regions to contribute to the project review, to mainline the role of farmers in the project, and to the initiation of the farmer-managed trials, A1051, R8179; 27 July - 31 August 2003. Natural Resources Institute (NRI), Chatham, UK. 4 pp.

MORRIS, M. (2003) Back to Office Report of Visit Number 9934: Team work and site visits for the 'small-scale utilisation of diatomaceous earths during storage' project, A1051, R8179; 8 October - 1 November 2003. Natural Resources Institute (NRI), Chatham, UK. 4 pp.

MORRIS, M. (2004) Rationale and protocol for 'Enquiry Visit I' (Dr2), June 2004. Natural Resources Institute (NRI), Chatham, UK. 5 pp.

MORRIS, M. (2004) Rational and training protocol for Bwanashambas (Dr1), June 2004. Natural Resources Institute (NRI), Chatham, UK. 3 pp.

MORRIS, M., KITANDU, L., KATUA, M., MVUMI, B. and STATHERS, T. (2003) Grain Storage Stakeholders Workshop. Report of a workshop organised by the Plant Protection Services (IPM Project)/ Western/ Lake Zone (Tanzania), the Natural Resources Institute (UK) and the University of Zimbabwe, 8th November 2002, IPM Project Compound, Shinyanga, Tanzania. Natural Resources Institute (NRI), Chatham, UK. 29 pp.

MORRIS, M. and MVUMI, B.M. (2003) Farmer Participatory Approaches: Developing the Agenda. Natural Resources Institute (NRI), Chatham, UK. 10 pp.

MORRIS, M., RIWA, W., MVUMI, B., MNGARA, K., MOSHA, R., MATHIAS, D., KITANDU, L., MAIGE, I., MAYANZI, B. and STATHERS, T. (2003) Report of a PM&E Workshop organised by the Plant Health Services, the Natural Resources Institute (UK) and the University of Zimbabwe, on the 19th October 2003, at the Royal Hotel, Babati, Tanzania. Natural Resources Institute, Chatham, UK. 24 pp.

MORRIS, M., RIWA W., STATHERS, T. and KITANDU L. (2003) Review Workshop. Report of a Workshop organised by the Plant Health Services and the Natural Resources Institute (UK) to facilitate the Crop Post Harvest Programme review, 6th August 2003, IPM Project Compound, Shinyanga, Tanzania. Natural Resources Institute (NRI), Chatham, UK. 45 pp.

MORRIS, M., STATHERS, T. MVUMI, B.M. and RIWA, W. (2004) Small-scale farmer utilisation of diatomaceous earths during storage project R8179: An institutional history. Natural Resources Institute (NRI), Chatham, UK. 14 pp.

MORRIS, M., STATHERS, T.E., RIWA, W., MVUMI, B.M., KITANDU, L., KAONEKA, B., MOSHA, R., MNGARA, K. and MATHIAS D. (in prep) Farmer Participatory Technology Development; Principals and Practice: A manual setting out the principles underpinning the project's on-farm research, and introducing and developing procedures, methods and tools for mainlining farmers in the design, experimentation and assessment of post-harvest technical options. Natural Resources Institute (NRI), Chatham, UK. 16 pp

MORRIS, M. and STATHERS, T. (2003) Mainlining farmers – protocol and practice: Record of a series of meetings held in Babati, Arri and Tengeru in preparation for initiating the farmer-managed trials. Natural Resources Institute (NRI), Chatham, UK. 11 pp.

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MVUMI, B.M. (2004) Graphs of the efficacy of the different grain protectants used in the Zimbabwean researcher managed DE trials during 2003/2004 storage season. University of Zimbabwe (UZ), Harare, Zimbabwe. 2 pp.

MVUMI, B.M. (2005) Summary of the Zimbabwe 2004/2005 DE trials after 20 or 24 weeks of storage. University of Zimbabwe (UZ), Harare, Zimbabwe. 3 pp.

STATHERS, T. (2002) Back to Office Report of Visit Number 9331a: Visit to participate in and monitor 'Small-scale farmer utilisation of diatomaceous earths during storage' project activities in Tanzania, R8179, 14 October - 13 December 2002. Natural Resources Institute (NRI), Chatham, UK. 6 pp.

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STATHERS, T. (2004) Preliminary data analysis of grain samples taken from the researcher managed DE trials in Tanzania during 2003/2004 storage season. Natural Resources Institute (NRI), Chatham, UK. 3 pp.

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STATHERS, T., RIWA, W., MORRIS, M. and MVUMI, B. (2004) CPHP impact matrix: Small-scale farmer utilisation of diatomaceous earths during storage project R8179. Natural Resources Institute (NRI), Chatham, UK. 5 pp.

STATHERS, T., RIWA, W., MOSHA, R., KITANDU, L., MNGARA, K. and KAONEKA, B. (in prep.) Farmer assessment of grain protection trials in Tanzania: Report of a participatory evaluation of the 2002/ 2003 storage season diatomaceous earth grain protection trials by farmers in the five trial sites in Shinyanga, Dodoma and Manyara regions of Tanzania. Natural Resources Institute (NRI), Chatham, UK. 41 pp. [English and some Swahili]

Other dissemination of results

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AGRICULTURAL REPORTER (2003) Diatomaceous earths as grain protectants and field trials in Shinyanga region. Radio Free Africa. 7 August 2003 (1300 and 2000 hours). Tanzania. [Radio report] [National] [Swahili]

AGRICULTURAL REPORTER (2003) Prospects for use of diatomaceous earths as grain protectants in Tanzania. Radio. 7 April 2003 (am and pm). Tanzania. [Radio report] [Swahili]

FARMER EDUCATION UNIT (2004) Diatomaceous Earths as grain protectants and setting up trials in Mlali village, Kongwa district, Dodoma region. Camera work and reporting by the Tanzanian Ministry of Agriculture and Food Security Farmer Education Unit and the Central Zone Plant Protection Co-ordinator, Damian Gasana. 22 May 2004 (2000 hours) 1 hour. Tanzania. [Village film show watched by >300 people, venue outside Mlali village Ward Executive Office] [Swahili]

GIGA, D.P. (2003) Review of project: Small-scale farmer utilisation of diatomaceous earths during storage. Project review report. Crop Post Harvest Programme, Natural Resources International (NRIL), UK. 31 pp.

GOMO, M. (2004) Field assessment of the efficacy and persistence of a locally-occurring raw diatomaceous earth in protecting stored maize and cowpeas on small-scale farms under semi-arid conditions in Zimbabwe. Report of final year project proposal, to be supervised by B. Mvumi, University of Zimbabwe (UZ), Harare, Zimbabwe. 17 pp. [Proposal also orally presented to 20 students and lecturers at UZ].

JANGA, F. (2004) Efficacy of a locally occurring diatomaceous earth as a grain protectant in smallholder stores under sub-humid conditions. Final year undergraduate special project dissertation supervised by B. Mvumi. University of Zimbabwe (UZ), Harare, Zimbabwe. 37 pp

JANGA, F. (2004) Efficacy of a locally occurring diatomaceous earth as a grain protectant in smallholder stores under sub-humid conditions. Paper presented at Innovative Agricultural Engineering Student Competition organised by University of Zimbabwe and Zimbabwe Institution of Engineers, University of Zimbabwe, Harare, Zimbabwe. 23 June 2004. 13 slides. [Presentation] [Selected as best agricultural engineering project in the student competition, attended by ~200 guests including students, academics, researchers, agrochemical companies, public sector and the Vice Chancellor]

KAPARADZA, V. (2004) Evaluation of African diatomaceous earths (DEs) as potential maize grain protectants against the rust red flour beetle (*Tribolium castaneum*). Final year undergraduate special project dissertation supervised by B. Mvumi and P. Jowah. University of Zimbabwe (UZ), Harare, Zimbabwe. 54 pp.

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KITANDU, L., KATUA, M., KAREGA, P. and KOLOWA, H. (2002) DE issues have been integrated into IPM training sessions (and farmer field days) for farmers, plant protection officers, village extension workers, NGO staff within and outside Shinyanga [Farmer field days - Maswa district May 2002, Bukombe district March 2002; Plant protection officers - Shinyanga 4-5 Sept 2002; Village extension officers - August 2002; CARE Tanzania (Mwanza, Misungwi, Magu) - 18-21 November 2002; World Vision Tanzania (Nzega, Shinyanga) - December 2002; Catholic Diocese Agricultural Program (Shinyanga) - September 2002].

KITANDU, L., KATUA, M. (2002) During plant protection officer's visits to districts both within and outside Shinyanga Region, discussions on DEs and the current trials have been held with district authority staff helping to create awareness about this work with these decision makers. Plans are in place for further outreach and dissemination of information about DEs and the trials when IPM measures are extended nationally, effective from January 2003.

MADZINGA, J. (2004) Efficacy of locally mined diatomaceous earths as maize grain protectants against major storage insect pests in smallholder stores under sub-humid conditions (2004/05 storage season). Report of final year project proposal, to be supervised by B. Mvumi, University of Zimbabwe (UZ), Harare, Zimbabwe. 18 pp. [Proposal also orally presented to 20 students and lecturers at UZ].

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MNGARA, K.K. (2002) Post-harvest training Hanang District, Tanzania, September 2002. [Training workshop for 20 Village Agricultural Extension Officers] [Swahili]

MNGARA, K.K. (2002) Food crop loss and storage management Same District, Tanzania, December 2002. [Training workshop for 14 SAPRO farmers and 4 SAPRO field officers] [Swahili]

MNGARA, K.K. (2002) Post-harvest loss management training course for World Vision for 26 villages in 6 wards in Arumeru District, Tanzania, 4-12 December 2002. [Training courses for 147 participants] [Swahili]

MNGARA, K.K. (2003) Safe Use and Handling of Pesticide training course in 3 regions (Manyara, Arusha and Kilimanjaro) of Tanzania, 17-21 February 2003. [Training course for 60 pesticide stockists] [Swahili]

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MUKOYI, F. (2004) Evaluation of African Diatomaceous Earths (DEs) as potential grain protectants against the lesser grain borer (*Rhyzopertha dominica)*. Report of final year project proposal, to be supervised by B. Mvumi and P. Jowah, University of Zimbabwe (UZ), Harare, Zimbabwe. 14 pp. [Proposal also orally presented to 25 students and lecturers at UZ].

MVUMI, B., CHINWADA, P. (2003) DEs included in the Post Harvest IPM strategy at the LGB Training Workshop, Murewa Training Centre, Murewa, Zimbabwe, 2-5 September, 2003. [18 multi-institutional participants from Mashonaland East Province]. (Issue 1 of Project Newsletter distributed to the participants).

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MVUMI, B.M. and STATHERS, T.E. (2003) Challenges of grain protection in sub-Saharan Africa: the case of diatomaceous earths. Powerpoint Presentation, Food Africa International Working Meeting, Palais des Congrès, Yaounde, Cameroon, 5-9 May 2003. [140 participants from 30 countries]

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MVUMI, B.M., STATHERS, T.E., KAPARADZA, V., MASIIWA, P., JOWAH, P. and RIWA, W. (2005) Comparative insecticidal efficacy of five raw African DE samples against the stored grain insect pests, *Sitophilus zeamais* and *Tribolium castaneum*. Abstract submitted for International Conference on Biopesticides, Thailand, 13-14 February 2005. [Abstract]

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RIWA, W. and KITANDU, L. (2003) DEs included on the agenda in the series of IPM Sensitisation of Policy Makers one day workshops in Tanzania, 4 March - 9 September, 2003. [Series of one day workshops - Participants included MPs, RAS, DAS, DED, Mayors, Council Chairpersons, RAA, DALDOS and DEOs. The workshops have already been conducted in Tanga (4-6/3/03, 20 participants, 6 districts represented), Dodoma (9/7/03, 24 participants, Dodoma & Kongwa districts), Morogoro (9/7/03, 18 participants, Morogoro & Kilosa districts), Mbeya & Rukwa (23/8/03, 21 participants, Rungwe, Mbeya rural & Sumbawanga rural districts), Lindi & Mtwara (16 & 19/6/03, 37 participants, Mtwara, Masasi, Kilwa, Nachingwea, Tandahimba, Liwale, Newala, Naliendele, Lindi & Ruangwa districts), Mbeya (9/9/03, 45 participants, 3 districts)] [Kiswahili]

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STATHERS, T., RIWA, W., MATTHIAS, D., MOSHA, R., KITANDU, L. and MORRIS, M. (2003) Mlali village grain protection trials and first years field trial data. Natural Resources Institute (NRI), Chatham, UK. 3 + 5 pp. [Poster (Visual photo noticeboards presented by T. Stathers at the Southern Highlands Maize Seed Stakeholder Workshop, Iringa, Tanzania, 30-31st July 2003]. [Swahili]

STATHERS, T., RIWA, W., MVUMI, B. and MORRIS, M. (2002) Small-scale farmer utilisation of diatomaceous earths during storage: Could fossil dusts be an option for increasing food security in sub-Saharan Africa? Natural Resources Institute (NRI), Chatham, UK. 2 pp. [Flier] [90 copies distributed to wide range of stakeholders in Tanzania, from Oct-Dec 2002]

In addition to the above disseminations

- DE interactive grain protectant display was set up at both the Morogoro and Mbeya showground's for the farmers day agricultural shows 'nane nane day' 1–9 August 2004. The Plant Health Services of the Tanzanian Ministry of Agriculture and Food Security, to which the key project partners belong, was awarded first prize at the Mbeya showground. [>1000 farmers] [Display and discussion in English and Swahili]
- DEs have been incorporated into the Post Harvest IPM strategy taught to undergraduate students at the University of Zimbabwe.
- The DE trial sites in both Zimbabwe and Tanzania have been visited by different stakeholders, authorities and farmers from other regions.
- DE project information discussed with Tanzanian Minister of Agriculture, during a meeting in Mbeya, Tanzania in 2003 and at the farmers day showground in 2004.
- DE project website details have been circulated to the projects global database of grain storage stakeholders, and Food Africa conference participants from East, Central and Southern Africa.
- DE interactive grain protectant display was set up at the provincial agricultural show held in Mutare. 23-26 September 2004. The display was mounted by Buhera AREX, and the DE stand was visited by more than 100 farmers who asked numerous questions on availability, cost, persistence, safety period after treatment, sources of DE in Zimbabwe. [Display and discussion in English and Shona]
- Informal discussions occurred between B. Mvumi and Dorowa Minerals Ltd. staff on other potential uses of Chemutsi DE such as production of refractory bricks and other clay products. It was also mentioned that the company had hired someone to undertake a preliminary environmental impact assessment (EIA) of DE mining at Chemutsi in Zambezi Valley since the deposit is located in a game park. Another meeting between project staff (M. Morris and B. Mvumi) with Dorowa Minerals Ltd. Staff revealed that the preliminary EIA had been done and is to be submitted to Department of Natural Resources by mid September. Samples of Chemutsi DE sent by Dorowa Minerals for assessment in making refractory bricks gave good results and once EIA report has been approved further exploration will take place. Currently the bricks are imported from South Africa. Astra paints have also registered their interest in the DE for use in paint products.
- Discussions held with staff at the Ministry of Energy and Minerals in Dodoma, Tanzania during two visits by Mr. Riwa and Ms Mosha. Profiles of local deposits given samples obtained for the field trials and analysis. The Ministry of Energy and Minerals staff have been included in list of stakeholders receiving project reports/updates.
- Discussions held with Dr. Kevin Pixley of CIMMYT on DE project progress to date and gathered that in US, seed maize is protected using DEs.
- Hard copies of the DE project newsletter (issue 1) were circulated to stakeholders attending a DFID/NGO workshop on 'Reducing vulnerability and promoting sustainable livelihoods in Zimbabwe' held at Crowne Plaza Monomotapa, Harare, Zimbabwe, 17-19 February 2004. The workshop was attended by 145 participants including private sector, civil society, NGOs (local and international), donors, IACs.
- Interest from a range of stakeholders about the DE project as a result of the DE noticeboard in the Plant Health Services, Tanzanian Ministry of Agriculture and Food Security meeting room. This has provided opportunities to distribute project material/information and popularise the DE website. The Country director for Sasakawa Global 2000 was pleased to receive a report of the project and website address.
- Two colleagues from KARI Uganda were impressed with the results of the DE trials when they visited Mlali village during their "experience sharing tour of Tanzania" in April 2004. They took samples of DEs to Uganda for experimentation there and promised to exchange information with the project team.
- Results of African DE laboratory screening and on-station trials of African DEs were presented by F. Janga, P. Masiiwa and V. Kaparadza at 3 seminars held at UZ on 6 May 2004, 10 June 2004 and 11 June 2004. The presentations were part of undergraduate final year projects. The seminars were attended by 40 students and academic staff members in the Faculty of Agriculture at UZ.
- Informal discussions occurred between T. Stathers and staff of EPOPA 'Export Promotion of Organic Products from Africa' about the DE projects activities and the fact that DEs can be used on organically certified stored grains and the registration issues we are facing.
- The diatomaceous earth, Protect-It, has been included in the maize seed storage trials being run as part of the 'Improving farmers access to and management of disease resistant maize cultivars in the Southern Highlands of Tanzania' project led by Uyole ARI, Mbeya, Tanzania.
- 300 caps and 100 T-shirts bearing the project logo were printed, these are being carefully distributed to the project team, collaborating farmers, and key policy individuals. (T-shirts and caps were worn during the recent 'nane nane farmers day' activities and during trial setting in the villages.)
- The Training Branch of AREX in Zimbabwe prepared some radio programmes for Radio Zimbabwe based on the workshop on DE Farmer Participatory Trials held in Buhera in May 2004. However, airing the

programmes by the institution is problematic because of recent policy changes which now charges high prices for the air time.

Listing and reference to key data sets generated

Data set	Location
R8179 - Researcher managed DE field trials data for Tanzania	Originals of Mlali, Arri and Singe village trials with Rachel Mosha at MAFS Kurasini office, Dar es Salaam rachelmosha@yahoo.com Originals of Mwamakaranga and Mwataga village trials with Lazaro Kitandu at IPM office, Shinyanga lazkitandu@hotmail.com Electronic copies with Tanya Stathers, NRI, UK T.E.Stathers@gre.ac.uk and William Riwa, MAFS, Temeke, Dar es Salaam wilriwa@yahoo.com
R8179 - Researcher managed DE field trials data for Zimbabwe	Originals and electronic copies of Buhera, Binga and IAE data with Brighton Mvumi at UZ, Zimbabwe mvumibm@agric.uz.ac.zw
R8179 – Farmer enquiry data for Tanzania	Originals with Rachel Mosha at MAFS Kurasini office, Dar es Salaam Electronic copies with: Mike Morris m.j.morris@gre.ac.uk and Tanya Stathers, NRI, UK; Rachel Mosha and William Riwa, MAFS, Tanzania.
R8179 – Farmer managed trials in Zimbabwe	Originals and electronic copies with Brighton Mvumi, UZ, Zimbabwe.
R8179 – NRI laboratory data on sub-Saharan African DEs	Originals with Tanya Stathers, NRI, UK. Electronic copies with Tanya Stathers and William Riwa, MAFS.
R8179 – UZ laboratory data on sub-Saharan African DEs	Originals and electronic copies with Brighton Mvumi, UZ, Zimbabwe.
R8179 – Diatom Research and Consulting data on sub-Saharan African DEs	Originals with Zlatko Korunic, Diatom Research & Consulting, Canada, zkorunic@rogers.com Electronic copies with: Zlatko Korunic; Tanya Stathers, NRI, UK; William Riwa, MAFS, Tanzania; and Brighton Mvumi, UZ, Zimbabwe
R8179 – Photographic collections from Tanzania	Originals and electronic copies (if existing) with Rachel Mosha, William Riwa, Tanya Stathers and Mike Morris
R8179 – Photographic collections from Zimbabwe	Originals with Brighton Mvumi
R8179 – Electronic coalition team communications	Electronic versions with Tanya Stathers, William Riwa, Brighton Mvumi and Mike Morris.