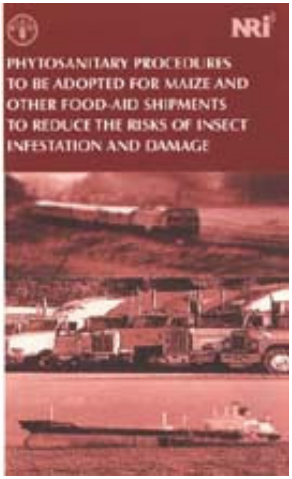

Phytosanitary procedures to be adopted for maize and other food-aid hipments to reduce the risks of insect infestation and damage

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Introduction

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This report describes both the technical control measures to be used to

protect grain from insect infestation during transit and storage, and the precautionary measures necessary prior to its procurement.

It has been produced following a technical consultation on quarantine standards relating to the import and export requirements for maize in Eastern and Southern Africa, which took place during the period 14-18 February 1994, at Maputo, Mozambique. The consultation was arranged within the framework of the FAOoperated projects TCP/RAF/2734 and GCP/RAF/300/EEC, and was organised jointly by FAO and the Natural Resources Institute (NRI).

Countries represented at the consultation included: Botswana, Burundi, Kenya, Mozambique, Rwanda, Swaziland, Tanzania, Uganda, Zaire, Zambia and Zimbabwe. In addition, there were representatives from the Southern Africa Development Community (SADC), the Southern African Regional Commission for the Conservation and Utilisation of Soils (SARCUS), and the Preferential Trade Areas (PTA) of the Eastern, Central and Southern African countries.

The principal objectives of the consultation were:

to review and approve a draft version of:

- Phytosanitary Guidelines for Eastern and Southern Africa to Minimise the Spread of the Larger Grain Borer (LGB); the main purpose of this guide, which is a major output from the FAO/EEC Regional Project on LGB, is to optimise phytosanitary operations to facilitate commercial and food-aid import, export and transit of maize
- to discuss and demonstrate shipboard and other technologies for the effective disinfestation of maize.

Major conclusions of the consultation were:

- that technologies are available to control LGB and other insect pests in grain under any situation
- that it is essential that this be clearly understood by those responsible for procuring and transporting grain
- that the appropriate authorities in individual countries must be able to

implement effective control procedures

- where necessary, improvements in these procedures must be made through timely training programmes.

Summary

Technology is available to eliminate all types of insect infestation from maize and other food-aid commodities and at all stages of transit from producer to consumer. There are however, situations where complete elimination of insects is not justified either on economic or environmental grounds. Control of insects is dependent on application of the appropriate technique under suitable conditions. For effective disinfestation using fumigants the two most important factors are provision of a gas-tight enclosure and good distribution of gas throughout the commodity.

It is essential that contracts for the supply of infestible food-aid commodities

indicate clearly the control measures that should be used and the conditions under which they must be applied.

Background

Cereal grains and similar commodities are continually at risk from insect infestation particularly in warmer climates. Although phytosanitary legislation exists to prevent the international movement of particular pests such as the Khapra beetle (Trogoderma granarium), and procedures to control this and any other commodity pest are well established, the correct procedures very often are not always followed. As a consequence commodities frequently arrive infested at destination ports, causing delays in delivery, demurrage charges and with added costs of disinfestation, the responsibility for which is often not clear. In addition, current sampling techniques mean that sometimes it is not possible to detect infestation until after discharge has commenced which causes contractual problems as well as causing infestation

problems for the recipient. Contracts to purchase often fail to contain clauses clearly indicating the need for suppliers and transporters to ensure freedom from insects in food-aid commodities at all stages until final delivery.

In the last decade, a particularly injurious insect pest the Larger Grain Borer (LOB, Prostephanus truncatus, Plate 1) has been accidently introduced into Africa because of a failure to detect the pest in imported commodities. This pest can cause extensive damage to stored maize and dried cassava at farm level, and countries neighbouring those already harbouring the pest have been strenuous in their efforts to prevent its entry. The recent drought in Southern Africa, in which large quantities of grain were moved internationally, has highlighted a general need to strengthen phytosanitary procedures in all shipments of infestible commodities traded internationally including food-aid.

Infestation and damage in grain, pulses, and processed products

In international trade the Khapra beetle has been regarded as a dangerous pest for several decades and many countries have quarantine regulations to prevent its importation, specifically to avoid the costly eradication programmes that would become necessary. The arrival of the Larger Grain Borer has caused many African countries to regard this pest in a similar manner and to review and strengthen their phytosanitary programmes to reduce the risk of the pest entering on imported commodities.

The supply of insect-free food commodities to the developing world is increasingly important.

Commonly found insect pests moving in internationally traded food commodities are now regarded as cosmopolitan and in most countries not subject to quarantine restrictions being regarded as indigenous. However, these pests are often harmful to the commodities they infest and their presence is decreasingly tolerated. Insects which readily infest milled and processed products (sometimes referred to as secondary pests) such as the red flour beetle (Tribolium castaneum) are now world-wide in distribution and can infest a wide variety of products. Insects often termed primary pests

are able to infest grain in the field before harvest. Examples of these pests are the maize weevil (Sitophilus zeamais) and the Larger Grain Borer. These insects are usually less generally widespread throughout the post-harvest system than are secondary pests and, if found in food-aid shipments, indicate that disinfestation treatments after harvest were ineffective or possibly not carried out at all.

Damage to maize and other food-aid commodities by insects may vary with the type of commodity and severity of infestation. A loss in commodity weight due to consumption by pests will affect both its quantity and quality. Heating of the commodity due to the presence of insects may also lead to moisture movement and the development of moulds and mycotoxins.

Plant importation licences and phytosanitary certificates

An understanding of the system of Phytosanitary Importation Licences and

Phytosanitary Certificates can reduce unnecessary costs which have been experienced by some grain importers due to non-compliance with established and modernised international phytosanitary procedures.

Plant Protection Services

Plant Protection Services (PPS) provide a service to importers of grain and other agricultural products which facilitates trading.

The important requirement to slow down the spread of pests and diseases of crops and thereby reduce losses and pest control costs leads to the need for a national service to the agricultural trading community. This service consists of specialists in pests and diseases plus trained technicians who provide on-site inspection services.

A particular need now is to slow down the spread of the Larger Grain Borer which is a very destructive insect pest of dried food maize, seed maize and dried cassava after harvest.

Importation of food grains

For food grain importers, including donors, the PPS provides an opportunity to ensure that grain is treated before or at shipment to comply with the requirements for safe import into receiving countries. In most developing countries agricultural products are received into mixed-cargo transit warehouses which means that, once infested, neglected consignments can transfer insects to better kept consignments (Plates 2 and 3).

International donors are asked to inform their headquarters' purchasing organisations of the Phytosanitary requirements for imports of grain.

Before contracting for the supply of a grain cargo every grain importer should apply to the Phytosanitary Inspection Service of the receiving country for a Plant Importation Licence or Permit (P.l.P.) in which the PPS can specify what pest control treatment should be applied to the grain before it is shipped.

This will enable the PPS of the supplying country to advise exporters on the correct treatment, ensure that it has been applied and issue a Phytosanitary Certificate to record the treatment and the results. The need for the correct treatment can be specified in the contract and foreseeable costs can be allowed for.

In the future the treatments specified by the PPS will be expected to follow the FAO Phytosanitary Guidelines for Eastern and Southern Africa. These Guidelines are set to protect importing countries against the Larger Grain Borer and other grain pests.

Condition on arrival

If live insect pests are found in grain on arrival, fumigation or refumigation will have to be carried out.

Further information

Facilitating Regional Trade of Agricultural Commodities in Eastern, Central

and Southern Africa. Collected and edited by R. L. Semple and G. l. Kirenga, Dar es Salaam University Press. ISBN 9987 24002X. A phytoguide published in 1994, and available in English, French and Portuguese providing detailed information on methods of grain treatment and especially on the complex subject of safe and effective fumigation of grain in ships' holds.

Obtaining a Phytosanitary importation licence can avoid unnecessary costs.

During 1992-1994 (to date) 21 ships (41%) out of 51 arrived in one Eastern African port without presenting a Phytosanitary Certificate to the port Phytosanitary inspection Office. This led to delays in discharge and will do so again in the future if the necessary documentation is not presented.

Some ships have arrived with a Fumigation and Phytosanitary Certificate for the grain cargo recording fumigation with phosphine for only three days. The grain had to be re-fumigated using a five-day exposure period and extra costs were incurred.

Pest control techniques for phytosanitary treatments

The two major techniques presently used for commodity disinfestation are:

fumigation and application of contact insecticides.

Plate 1 Prostephanus truncatus (Larger Grain Borer)

Plate 2 Bulk grain arriving by ship off-loaded directly into mobile bagging-off plants wherever possible

Plate 3 Bag-stack in a warehaouse

Plate 4 Insecticide treatment of a loaded rail wagon against the Larger Grain Borer

Plate 5 Portable fan-assisted fumigation injection system(a)

Plate 5 Portable fan-assisted fumigation injection system(b)

Plate 5 Portable fan-assisted fumigation injection system(c)

The principal advantage of fumigation is that it can be used to treat commodities in situ without extra handling operations. Contact insecticides, usually in the form of water-based sprays, may be used in conjunction with fumigation, specifically to minimise reinfestation, or alone for direct application to bulk grain during loading/unloading operations. Where quarantine treatments of commodities are necessary, these usually need to be undertaken as quickly as possible, with fumigation being the only option available.

Chemicals used for fumigation

Only two fumigants are in world-wide use, methyl bromide and phosphine.

The great advantage of the former, which is applied direct from cylinders, is that insect control can be achieved within 24 hours. Phosphine is mostly

obtained by the action of atmospheric water vapour on solid aluminium phosphide preparations. An emerging problem of insect resistance has resulted in the recommended exposure period for phosphine being increased from three to a minimum of five days and in many situations much longer is necessary. Considerable uncertainty exists regarding the continued availability of methyl bromide because of its recent identification as an ozone-depleting substance.

Contact insecticides for protecting food grains

These may be used for direct application to commodities, usually unprocessed cereals, for controlling existing infestation and to provide residual protection. They are also applied as surface treatments to walls and floors of containers in which commodities are stored or transported (Plate 4), to control existing infestation prior to loading, or preventing later cross-infestation or reinfestation. Surface spraying of bag-stacks is commonly carried out to help prevent re-infestation or cross-infestation of commodities following delivery or fumigation.

It is now recognised that the surface spraying of bagged commodities is unlikely to prevent entirely cross-infestation by insect pests and, that where the storage period is prolonged, fumigation may be required on one or more occasions. Insecticides used to protect food commodities are few in number and fall into two groups, organophosphorus and synthetic pyrethroid compounds. Both types are not equally effective against all insect pests and it is therefore essential to select an insecticide appropriate for the pest species to be controlled.

Where a complex of insects is present it may be necessary to apply more than one insecticide.

Potential for infestation in food grain shipments

The origin of insect pests in food grain shipments is potentially diverse and infestation may take place at any one of several stages.

Country of production

In countries with climates favourable to insects, pests can be carried with crops from the field into stores and into the postharvest system, where infestation will develop further unless effective control measures are employed. Reinfestation may also be a persistent problem during handling and storage, and additional fumigations of commodities may be necessary if storage is prolonged, except where commodities are in silos. If, in a particular situation, reinfestation is known to be a problem, it is essential that bagged commodities are fumigated and surface sprayed with contact insecticide within a defined period (often seven days) prior to despatch. This will ensure as far as possible, that the commodity is free from live infestation at the time of departure.

Residual insect infestation in ships, rail wagons and freight containers

Insect pests can persist in commodity residues in ships or vehicles that are not properly cleaned out after discharge. Newly loaded commodities can quickly become infested under such conditions, and where the journey time is

several weeks, especially in hot climates, the level of infestation can increase dramatically.

Cross infestation of cargoes during shipment

Where vessels call at other ports to take on cargoes before reaching the final destination, if these cargoes are infested there is a possibility for cross-infestation of cargoes already on board.

Infestation at destination ports

In the port and adjacent areas of many developing countries permanent infestation by insects such as the flour beetle is very common in transit sheds and other buildings used for commodity storage. As a consequence, it can be expected that maize and other food grains which remain in or near the port for longer than two or three days will become infested. If, however, after discharge from ships, commodities are distributed locally and used quickly, infestation may not take place and control measures will be unnecessary.

Infestation during land transit

Food grains may become infested during road or rail transit between countries. The principal source of insects is probably residual infestation in transport vehicles. A further possibility is where temporary storage becomes necessary between vehicular transfer.

Is control of pests always necessary ?

The presence of a few insect pests such as flour beetles or moths on the surface of stacks is unlikely to cause significant damage to food commodities stored for a short period only and does not always warrant the cost of fumigation. Surface spraying with contact insecticides may, however, be justified as a protective measure during short-term commodity storage. Where the period of storage in or near the port is prolonged, or the food grains are destined for an inland country, and requiring a further period of

transit, insect numbers may increase rapidly and further control measures will become necessary.

Factors affecting fumigation efficiency

Two key factors influence fumigation effectiveness

- provision of gas-tight conditions in which sufficient gas is retained for the required time-period
- ensuring fumigant is completely distributed throughout the commodity.

Fumigation should only be carried out in well-sealed enclosures and, although it may be possible to compensate for loss of fumigant in some circumstances by further additions of gas, this is not usual practice, and only normally considered where gas concentrations can be continually monitored and 'topping up' accurately compensates for losses. Purpose-built silos and bag-

stacks under sheets offer some of the best conditions for good gas retention permitting effective commodity disinfestation. Freight containers can also prove very effective for fumigation purposes. Where bulk commodities that are not stored in silos are to be disinfested, the distribution and retention of gas can be difficult, ships being particularly problematic in this respect.

Phosphine has almost the same density as air and is little sorbed by commodities and distributes well; there is usually no need for external assistance by forced circulation, except in deep silos or other large bulks such as in ships. Methyl bromide is more than three times heavier than air and, in addition, is highly sorbed by finely divided commodities and those with a high oil content. As a consequence distribution of methyl bromide is generally more difficult than phosphine and greater attention is necessary to the methods used for application, and in ensuring that the appropriate quantities of fumigant are employed.

Fumigation of bulk grain with methyl bromide should only be undertaken using a system of forced circulation which provides effective gas distribution throughout the commodity. If fumigant is applied only to the grain surface,

without forced air movement to assist distribution, most of the chemical will sink rapidly and unevenly to the bottom with little, if any, retention at the surface and in other upper areas of the bulk. Disinfestation of grain under such circumstances is almost certain to be ineffective.

The physical conditions under which fumigations are carried out can influence the effectiveness of disinfestation. Grain is more easily disinfested at higher temperatures and, where the moisture content is below 9%, the evolution of phosphine from aluminium phosphide preparations will be very slow and must be aided by provision of moisture from an external source.

Factors affecting fumigation of grain

Bag or bulk

The way in which grains are stored, i.e. in bulk or in bag, can markedly affect

the method of disinfestation used and its potential effectiveness. For bulk grain, methyl bromide cannot be used effectively without a re-circulation system to aid gas distribution as indicated above. This system may be pre-installed or of the portable variety, employing an injection technique (Plate 5). In shallow grain bulks successful fumigation is possible by probing with aluminium phosphide tablets. In silos however, if phosphine is used, a recirculation system to aid gas distribution will also be required. The only alternative if this is not possible is to transfer the commodity to an empty silo with addition of aluminium phosphide to the grain stream during loading.

Bagged grains and other food commodities are commonly fumigated under gas-tight sheets, particularly in developing countries but also sometimes in the holds of ships. Either methyl bromide or phosphine can be used for treatments of this type. However, when using methyl bromide in ships' holds with bagged goods, re-circulation is essential. Neither the commodity to be disinfested nor the insect pest to be controlled normally influence the selection of fumigant. Only where seed materials are to be treated is methyl bromide best avoided due to its potential to adversely affect germination.

Time available

An important factor affecting fumigation is the time-period available for treatment, and this may also influence the fumigant selected. Where quarantine fumigations are to be carried out, such as in ships awaiting discharge, speed is of the essence to reduce demurrage charges. Methyl bromide is generally used under these circumstances since it provides the most rapid means of disinfestation. This fumigant requires a higher level of operator training than phosphine, both to attain effective gas distribution, and from considerations of safety. Because phosphine appears to be much easier to apply it is often preferred except where rapid disinfestation is necessary or where methyl bromide is specified in contracts or required by regulation.

Situations in which fumigation of grain is likely to be carried out

In countries of origin

In the countries where food commodities are produced it may be necessary to fumigate bag-stacks under sheets in storage buildings or in the open, grain in shallow bulks or in silos. Other circumstances where fumigation may be necessary are in rail wagons, freight containers, barges and ships. Effective treatment is possible in all these situations but the degree of effectiveness will be dependent upon the competence of the pest control contractor.

On board ships

Fumigation in ships can be one of the most difficult situations in which to be certain of effective disinfestation. The condition of the vessel as well as competence of the pest control contractor is an important factor (see pare 56). Bulk carriers are easier to seal effectively than 'tween deckers' end the best practice is to consider only bulk carriers as suitable for fumigation whilst in-transit. 'Tween-deckers' can normally only be safely fumigated whilst berthed and with the entire ship's crew ashore. This is necessary to avoid exposure of crew members to fumigants which, in 'tween deckers' may leak

through ducting into quarters. There have been a sufficient number of incidents in which this has occurred to indicate that 'tween deckers' should never be fumigated whilst at sea unless the holds have been previously checked and certificated as gas tight.

The effective sealing of ships can present problems and this factor, together with the practice of applying fumigant to the surface of bulk grain only, frequently leads to fumigation failure and survival of insects. There have been instances where a ship has been fumigated four times before reaching its final destination, and live insects were still found in the grain. Methodology exists for testing empty holds for gas tightness and where it is possible this should be carried out prior to fumigation as this, together with an effective distribution system, will provide the basis for effective fumigation.

In barges

These may be fumigated prior to loading commodities on to ships or where cargoes are taken off ships. Effective sealing of hatches is essential and where grain is in bulk, even distribution of methyl bromide will not occur if gas is

applied to the surface only. Safety of any crew aboard barges must be considered if they remain during the fumigation.

In road and rail transport

Road transport vehicles are not usually suitable for fumigation, and where cross-border movement of food grains takes place, any disinfestation necessary should be done before loading and crossing the border. This may include fumigation of the commodity and cleaning of vehicles with application of surface sprays of contact insecticides both inside and outside where deemed necessary. Although freight containers are suitable for fumigation purposes and are often carried by road, journey times are usually too short for effective disinfestation unless methyl bromide is used, and safety precautions are difficult to implement satisfactorily. It is unfortunate that experience has shown that food-aid can transfer insect pests which seriously threaten the food security of the recipient country.

Fumigation in rail wagons is common in some countries but should only be carried out in bulk tankers which can be effectively and safely sealed.

Phosphine is the only suitable fumigant for rail wagons and is applied during loading. It can only be used when the journey time is at least five days.

Main considerations for donor organisations in reducing the risk of insect infestation in maize and other food-aid commodities

In contract tenders for food commodities liable to insect infestation, potential suppliers of commodities and transportation must be adequately instructed in the purchaser's requirements for minimising the risks of infestation taking place.

Insect infestation of commodities may occur at any one of several stages between purchase by donors and final delivery. Some of the stages and reasons why this may occur are as follows:

- in the country of origin - control procedures inadequate or infestation

not detected; statistically it is almost impossible to detect infestation levels of less than 5 insects/kg;

- loading on to ships containing residual infestation;
- cross-infestation as a result of ships taking on infested cargoes at other ports;
- commodities cross-infested whilst remaining in port areas prior to onward transportation;
- commodities cross-infested during transport to landlocked countries - vehicles contain residual infestation.

Contracts must stipulate that food grains are inspected, preferably prior to purchase, for insect infestation, and a report provided. Certificates should state that the grain must be free of live insects at discharge. Where fumigation is necessary, contracts should provide instructions on the method or methods of treatment that may be used. If methyl bromide is employed, contracts should stipulate the dosage rate and method of fumigant application. It is essential that, where bulk commodities are to be fumigated with methyl bromide, a system to re-circulate the gas is used. Without this facility penetration of the grain by the fumigant will be uneven and survival of

insects is probable. In addition, unless methyl bromide is ventilated fully, and rapidly, unacceptably high residues will remain in the commodity. If phosphine is to be used, the rate, minimum exposure period and acceptable distribution method should be specified, which should be by re-circulation or fanassisted infection.

Ships contracted to transport food grains must be watertight at deck level to prevent wetting of the cargo by both sea and rainwater. Fumigation of damp grain may prove ineffective due to chemical degradation of methyl bromide and/or inadequate penetration of the gas. Ships should also be in sufficiently good condition that fumigation will be effective if this becomes necessary. A test of the holds for gastightness should preferably be carried out especially if the ship is old or badly rusted, and there are doubts about its condition. Where tests indicate that holds are difficult to make gastight using superficial sealing techniques the ship should be rejected and an alternative sought. This might have to include rejection of the grain cargo because the ship is unfumigatable.

Where inspection of a ship prior to the loading of commodities reveals the

presence of live insect pests, contracts should indicate the method of treatment that can be used to disinfest holds and which may be either fumigation or application of insecticidal sprays. The insecticide or insecticides to be applied must be of the type known to provide effective control of the insect species found and they must be applied using an effective method.

If live insect infestation is detected in commodities already loaded on ships, in-transit fumigations must not be carried out except in bulk carriers. For vessels of the 'tween deck' type, fumigation must only be carried out when the ship is berthed and with crew evacuated for safety purposes. In the fumigation of bulk grain in ships a circulatory system must be used to ensure effective disinfestation at the bottom of holds. Unless a pre-installed perforated piping system is provided in the ship, a portable system involving injection must be used for both methyl bromide and phosphine.

Contracts should stipulate that, for all disinfestations of food grains using phosphine, a minimum exposure period of five days be used. With methyl bromide the exposure period may be 24 or 48 hours. Contracts must indicate the fumigant application rate for a 24-hour exposure, and this may be

reduced by one third where the exposure period is 48 hours.

In addition, the method of application to be used in ships must be clearly specified and should be:

- methyl bromide - re-circulation system
- phosphine - re-circulation or fan-assisted injection system

These are the only systems which, if used correctly, will ensure an even distribution of fumigant in strips' holds.

Is the ship fit to carry grain ?

Some ships for which fumigation has been required, due to the presence of live insects, have contained grain in such poor condition (wet and caked) that fumigation has not been successful and successive re-fumigations have been

needed. Fumigant gases will not easily penetrate into wet, caked grain, and consequently cannot kill the insects in it. Wet grain (e.g.17% moisture content) will also tend to cause chemical breakdown of methyl bromide reducing its effectiveness in controlling insect pests.

Five ships required successive (up to four) re-fumigations. Costs due to a delay of discharge of grain were greater than the cost of a well conducted initial fumigation by the exporter. Some adverse publicity to importers resulted.

In several instances the local fumigation company was not equipped to carry out a re-circulatory fumigation. They were asked to achieve control of insects when not equipped to do so.

Importers should ensure that their ship's holds are fumigatable. A ship which is not fumigatable because the holds are not gas-tight, or which is so old and leaky that grain in it becomes wetted and caked by rain or sea water, is unfit to carry grain. Recently three different fumigation companies have had to refuse to guarantee a complete kill of insects because of the poor condition of

the grain in a ship.

A successful result will be more probable if the grain is fumigated at or just before shipment' when it should be in the best possible condition. Nevertheless poor quality grain with a high proportion of dust and broken grains may prevent an effective fumigation being achieved.

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