How to take care of food and feed

PREVENT MOULD DAMAGE BEFORE HARVEST

It is essential that precautions are taken during the cultivation of the crop to prevent *Fusarium* in particular, and other moulds such as *Stenocarpella* and *Claviceps* from becoming established during the growing period.

There are various factors that influence the potential for pre-harvest fungi to develop, including the physiological and morphological state of the plant and climatic conditions. A plant that is not healthy is prone to infection by these parasitic fungi. In turn, the health of the plant is determined by its water and nutrient status and whether it is subject to other stress mechanisms, such as being attacked by pests.

Firstly, it is important to ensure that the seed used for planting is free from disease. Buying and planting certified seed is perhaps the best guarantee that the seed is disease free. However, not many farmers are able to afford certified seed, and usually resort to farm-saved seed, produced from the previous year's crop. Farm-saved seed will be safe to plant as long as it has not been infected whilst stored at the homestead. It is vital that such seed is free of pests and disease before planting, to ensure healthy, vigorous plants develop, i.e. those that are capable of withstanding attack during the growing season. Seed that is not free of infection will either not germinate or will produce weak plants that have a low threshold of resistance to pests and disease, and which will either succumb before a crop is produced, or will under yield.

Drought stress, caused by a lack of water, is known to facilitate attack by mould. Lack of water allows the plant to crack, and so opens passage ways through which fungal spores can enter. This can happen to the stem or to the head. Moulds can develop in the drying stems, which might be used for animal forage or hay, or in the grain, which will go to food or feed. Therefore, where irrigation systems function, farmers should always try to supplement local rainfall to avoid drought stress. If it is not practical to irrigate, plant and harvest as early as possible.

Good husbandry practices will generally help to fight against fungal invasion. It has become popular in recent years for farmers to practice zero or minimal tillage. This saves time and money, and where tractors or oxen are in short supply or where labour is difficult to hire, can save farmers and their families many days of tedious toil. However, these benefits have to be traded off against some negative effects. For example, without tillage, crop residues remain on the soil surface and these gradually deteriorate. These residues will harbour soil borne fungal spores, allowing them to over-winter, in time to infect the next crop. Similarly, without tillage these spores will remain in the surface layer of the soil in readiness to germinate.

Therefore, the benefits of minimal tillage have to be weighed up against the drawbacks. What is clear, though, is that with any minimum tillage operation, it is vital to keep the plot weed free and tidy whilst the crop is growing, to ensure the new plants avoid any potential infection arising from old vegetable material deteriorating in the vicinity.

Practising good plant husbandry, including weeding, will also help the plant fight against insect pests. Insect pests which damage the growing plant allow fungal spores openings through which to invade plant tissues. Thus action to reduce insect pest attack will keep fungal problems away. Thus in addition to practising good plant hygiene by keeping plots weed-free and tidy, insects must be kept at bay by using

commercial insecticide applications or other recommended methods of control, such as botanical pesticides or biological control.

Actions must be taken to minimise the damage from *all* pests that attack the growing crop, not just insects. Rodents, such as common and Norwegian rats and the house mouse, must be excluded. This is often difficult to achieve but every effort must be made. Once again, good plant husbandry, keeping the area clean and free of plant matter, will reduce the risk of rodent damage by limiting the number of harbourages. Removing vegetable matter in this way will reduce the amount of food available to the rodent and it may look elsewhere for a food source.

If possible, crops should be rotated from one season to the next. Crops grown on the same plot in successive years have been shown to have a much higher level of mould infection than when they are rotated. Rotation prevents a mould that is well established on one type of plant from having access in the following season, making it less likely for infection to reoccur. This applies not only to moulds but to other pests, such as insects and nematodes, as well.

Plant stress may occur even if the water available is adequate. If the nutrient content of the soil is lacking then the growing plant will always be stressed. This will be seen when plants become misshapen and internal tissues may be exposed as the stem breaks open. Lack of adequate soil fertility can be overcome by the judicious application of organic or inorganic fertiliser. However, applying too much fertiliser will also put the plant under stress and make it a prime candidate for attack by insects and moulds. It is therefore essential that fertiliser application is timely and in the correct quantity.

Timing the production cycle is also key to obtaining a healthy crop at harvest. Planting must take place at the recommended time to avoid problems caused by the crop maturing too early or more particularly, too late, during periods of prolonged rainfall. If plants mature when the relative humidity is high or whilst it is raining they will be prone to invasion by *Fusarium*, as well as being subject to pre-harvest damage by storage insect pests, which themselves will help with the diffusion and multiplication of mould spores.

It is always advisable to plant seeds varieties that are pest resistant. Varieties with resistance to insects and to viral and bacterial disease are available and should be used where the opportunity arises. In Tanzania and Uganda in East Africa, for example, farmers are able to grow maize and sorghum varieties that are resistant to Maize Streak Virus, Sorghum Leaf Blight, Grey Leaf Spot and Striga. Of course, this is not always possible because seeds of this type are not always available to buy, either locally or nationally. Furthermore, these varieties are usually more expensive to cultivate than non-resistant varieties, and certainly more so than locally produced seed. Nevertheless, if farmers do have the opportunity and the financial wherewithal to buy and use resistant varieties they should do so.

Cultivar differences exist for many pre-harvest factors including pest resistance, drought tolerance, stalk strength and husk cover. There are significant differences in keeping qualities between different crop varieties. 'Local' varieties of maize, which have small cobs with tight, elongated husks that completely enclose the ker-

FIGURE 7 **Tight husk of local maize variety**

nels, are relatively resistant to insect attack and therefore less susceptible to fungi. The sheathing leaves provide a physical barrier to entry. Composite and more particularly, hybrid varieties tend to have much poorer husk cover, the leaves fail to fully enclose the larger cobs of these varieties. Consequently, they are much more prone to damage by insects and moulds and extra care must be taken during crop maturation and drying to ensure that these varieties are not invaded by pests and diseases (in practice, without artificial drying, this is difficult to achieve where rains are prolonged). Conversely, the tight husks of small local varieties restrict water loss and slow drying.

The absence of a protective sheaf makes sorghums and millets more susceptible than maize. However, these crops do vary in their susceptibility due to the size and chemical constituents of the grain. Larger, soft grain varieties are more susceptible than those with small, hard grains, and the phenolic content of maize and sorghum is directly correlated with resistance to pest damage; red and brown sorghum is less susceptible than white. Sorghum heads that are open are more easily damaged by birds and so more prone to fungal invasion. Small grain millet is much less damaged by insects than larger sorghum grains and both are less susceptible than maize.

Unfortunately, there are few cereal varieties that are resistant to fungal attack and none have been developed that will resist *Aspergillus*. Varieties that will resist other moulds have mostly been developed for use in cooler, temperate climates and will not be of practical use to most tropical and sub-tropical farmers. These resistant varieties include, for example, a wheat variety developed in the US that is resistant to Fusarium Head Blight (not yet commercially available).

There are no *Claviceps purpurea* (ergot) resistant varieties but as sclerotia cannot survive for more than one winter in the soil, planting a non-susceptible crop in infected fields for two years will clear them out. The areas surrounding infected fields should also be cleared of susceptible plants. In severe cases, deep ploughing to bury sclerotia is also helpful.

BOX 3 ACTION TO TAKE BEFORE HARVEST TO REDUCE THE RISK OF MOULD CONTAMINATION AND MYCOTOXIN PRODUCTION

- use certified seed or ensure seed is free of fungal, bacterial or viral infection;
- avoid drought stress – irrigate if possible;
- sow seed as early as possible so that crop matures early;
- if practising minimum or zero tillage remove crop residues;
- weed regularly;
- control insect, mammal, bird and virus pests;
- rotate crops;
- avoid nutrient stress – apply appropriate amount of organic or inorganic fertiliser;
- plant resistant varieties where these are available.

PREVENT MOULD DAMAGE DURING HARVEST

The two most important factors that influence mould growth once the plant is mature are water activity and physical damage. When the maize cob, sorghum head, cowpea pod and groundnut pod have begun to dry in the field it is essential to dry them down to a safe moisture content as quickly as possible, and to do so with as much care as is practicable.

Rapid drying requires that harvesting be undertaken as soon as possible. However, delays to harvesting may be unavoidable if, for example, it is still raining; harvesting may then limit the rate of drying if the crop has to be kept in a heap which restricts aeration.

The decision to harvest must take into account several factors including:

- the prevailing climate,
- the likelihood of insect, rodent and bird damage, which might occur the longer the crop remains in the field; and
- the availability of drying facilities at the homestead or local storage complex after the crop is transferred from the field.

Where a farmer has access to drying facilities, for example at a buying centre, early, rapid harvesting and transporting of grain to the dryer within a day or two will be ideal. By this means, the crop can be dried to a safe storage moisture content and so mould attack and mycotoxin production can be avoided.

Most farmers will not have access to artificial drying facilities or will not be able to afford to use them. Nevertheless, whatever their circumstance, farmers must enable the crop to dry as rapidly as possible. The rate of drying will depend on harvesting practices, which vary greatly. Some producers simply leave the crop standing in the field for several months, especially if weather is dry and hot. In this case, ambient air movements and temperatures are sufficient to continually dry the crop down without the risk of moulds developing. There is a risk, of course, if unexpected rainfall occurs during this period, that moulds can develop.

The rate of drying in the field depends on the crop itself - maize kernels enclosed in sheathing leaves will dry more slowly than open sorghum heads – and on how it is treated. In many countries, it is common practice to bend the heads over on the standing plant as early as possible to speed drying. Farmers also cut cereals at the base of the stalk and pile the stalks with cobs or heads into conical bundles, known as stooks. This allows the field to be ploughed whilst the soil is still moist and soft but the tightly formed stooks may inhibit ventilation and slow drying. Some farmers lay bundles of stalks on the soil, and this is dangerous as it creates an opportunity for fungal spores in the soil to invade the grain. This happens with legume crops in particular, and has been a major cause of groundnuts becoming infected with *Aspergillus*. This problem can be avoided by placing a barrier between the crop and the soil, for example a layer of millet or sorghum stalks. Better still, place the crop on a platform raised above the ground.

Care must be taken not only to dry the cereal or pulse crop effectively but also the same practices must be used for drying stover, straws and haulms that are to be used as animal feed. Crop residues left lying in the field will dry slowly and are likely to be infected with mould spores. They should be placed on platforms so that there is no chance of contact with the soil, or tied together in upright heaps or stooks.

Still, it is better for the farmer to remove the crop from the field as quickly as possible and to dry it at the homestead.

FIGURE 8 **Maize stook**

BOX 4 ACTION TO TAKE DURING HARVEST TO REDUCE THE RISK OF MOULD CONTAMINATION AND MYCOTOXIN PRODUCTION

- harvest as quickly as possible
- avoid field drying
- transport the crop to the homestead as soon as possible
- if lack of labour or time prevents removal from field then dry on platforms raised above ground (if climate is hot and dry crop can be left to stand in field or cut and tied into stooks) to dry
- bundles of stover should also be placed on platforms to dry and not left to lie on the soil

Harvesting must be rapid but care must be taken to avoid damaging the crop. If the crop has been dried in the field then careless handling will not only result in grain shattering and weight loss, but will also cause grain damage and allow insect and fungal pests to invade. When harvesting with a tractor it is essential to ensure that the equipment is set up correctly to avoid grain breakage due to mechanical damage; this is especially important when using a tractor to thresh the crop.

Care must also be taken to ensure that silage is made under good anaerobic conditions with a low pH, to ensure that it remains free of mould and is safe to feed to livestock.

PREVENT MOULD DAMAGE AFTER HARVEST

Drying

Although drying begins before harvest it must be continued until the crop is put into store and, even then, further drying may still be necessary. Cereals harvested on the stalk or pulses in pods can be transported to the home and placed on platforms or frames to continue the drying process. Platforms must be raised so the floor is at least 0.7 m above the ground, the legs fitted with metal guards to prevent rodent access, and treated if necessary, to prevent termite attack.

The platform may be converted into a drying and storage crib having walls made from wire netting, bamboo, sisal poles, sawn timber or similar materials, which allow free movement of air across and through the crop. Maize cobs, sorghum or millet heads and legumes in shell should be less than 0.5 m in depth in the drying crib so that air movement is not impeded and drying restricted. The structure itself should be

FIGURE 9 A drying platform (a), drying frame (b) and drying crib (c)


(a)


(b)


(c)

no more than 1.5 m wide, and erected so that the long sides traverse the prevailing wind to allow a good flow of air.

Farmers often build these platforms above a cooking fire. This has the advantage of speeding the drying process and may also help to prevent pest damage whilst the crop is relatively exposed.

Drying crops spread thinly over the floor, whether on compacted soil or a concrete plinth, is acceptable if it is clean and well swept. Better still, a sheet of polythene or a tarpaulin-preferably black in colour to better absorb the sun's heat- or a layer of empty sacks, should be placed on the floor on which the grain can be spread. This will allow the crop to be quickly moved under cover when rain is imminent. Care must be taken to prevent the grain from being exposed to dust and other contaminants in the air, and to insects, rodents and browsing livestock.

FIGURE 10 **A solar dryer being used for drying chilli peppers**

Relying on ambient climatic conditions when the crop is spread out on the floor, tied to a frame, placed on a platform or in a crib may not dry the crop fast enough to prevent mould damage from occurring; such drying may take a month or more in high relative humidities. Only the use of a purpose built dryer will achieve the rate of drying required. The simplest are solar dryers, which collect the sun's heat inside a specially designed chamber that has adequate ventilation for removal of moist air. The most basic of these are natural convection dryers in which the airflow is induced by thermal gradients. These can be relatively cheap and simple to construct and are appropriate for use by individuals or small groups of farmers.

A second type of solar dryer is one in which a fan is used to force air through a solar collector and the grain. This type can handle larger quantities of grain, which can be loaded onto trays and placed in layers within the dryer.

Some commercial farmers and farmer groups may have access to larger-scale dryers operated by marketing boards, grain buying companies and millers and feed compounders. The opportunity to use such facilities should be taken, especially in areas where the prevailing relative humidity remains high through much of the year, for example, in much of West Africa and South East Asia.

Threshing, shelling and winnowing

Careful handling of the crop once it has dried can contribute significantly to the avoidance of mould damage once the grain is put into store.

In may parts of the world farmers and their families thresh or shell cereals and grain legumes by beating the crop, either loose or placed inside a sack, with a stick. This method is quick and simple but does cause heavy damage to the grain, especially of larger kernels of maize, beans and groundnut. It is also common for small grain

millets to be threshed in a mortar and pestle, a method that produces a large proportion of brokens. Storing broken grains may result in heavy mould infection and mycotoxin production especially in periods of wet weather or high humidity; where the relative humidity remains low for long periods, such as in Central and Southern Africa, mould attack may not occur. Furthermore, where grains are consumed quickly after threshing the presence of brokens will not matter.

Farmers often use their hands to shell maize, breaking grains from the cob between thumb and forefinger. Although this method can be laborious - it is usually a social occasion allowing family and friends to meet and talk – damage to the kernels is usually low and the quality remains good. Maize can also be shelled using a variety of hand-held gadgets or pedal-operated mechanical devices. All of these tend to produce good quality grain but are relatively scarce in farming communities. To work effectively, all these methods require the grain to be sufficiently dry for safe storage; if grain is wet threshing is difficult to undertake.

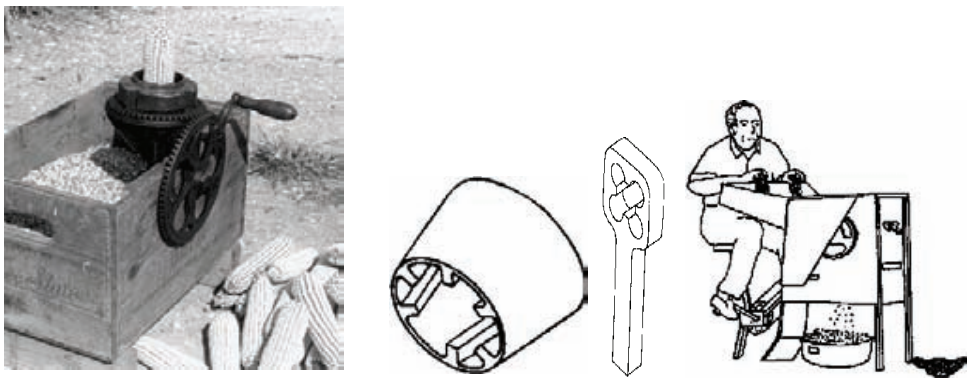
Commercial farmers may use tractor-driven shellers and threshers. Even these can result in substantial quantities of brokens if they are not correctly calibrated or set up, a common occurrence when farmers are not thoroughly conversant with a machine they may only have on hire.

Storage

Unthreshed produce

Once grain has been dried sufficiently it may be threshed before storage or left unthreshed. Small quantities of cereals on the head or grain legumes in pods may be stored loose within the house or store, on the floor, in containers such as used oil drums, in woven cribs or baskets, or on top of or beneath the roof.

FIGURE 11 **Various hand-held, bicycle operated and mechanical shellers**



It is bad practice to place food commodities directly onto an earthen floor as there is nothing to prevent moisture in the soil migrating into the grains. This will lead to mould and mycotoxin contamination. The same will apply even if the floor is concrete as it is still porous. However, if a water barrier, such as a polythene sheet, has been laid above or inserted into the concrete then the crop will remain dry.

Unthreshed commodities remain exposed to insect and rodent pests unless protective measures are introduced. For insects, this requires the application of either a conventional insecticide, such as Actellic 2% dust, or more traditional

FIGURE 12 **Rodent in a break-back trap**

protectants such as those derived from plants, e.g. 'neem kernel powder'. Commodities can be stored in the loft or roof space or on a platform above a fire. The fire will not only dry the grain but the heat and smoke may kill insects or drive them out of the grain. However, this is not always effective, as some insects, such as *Prostephanus truncatus*, the larger grain borer, can tolerate these conditions.

Against rodents, farmers storing crops in their house may, by themselves, provide sufficient disturbance to keep rodents at bay. Storage elsewhere may need more specific protective measures, such as baffles on the support poles of cribs, laying break-back traps, keeping the areas around stores clean and free of debris, and perhaps acquiring a cat. Rodent control is difficult to achieve because of the ability of the animals to avoid unfamiliar situations. The use of synthetic rodenticides on small-scale farms is not appropriate because of the inherent toxicity of most of the products marketed; their use would put at risk young family members, domestic animals and browsing livestock.

Threshed produce

Increasingly, farmers are storing cereals and pulses as loose grain. Grain can be stored in traditional or improved woven structures, in metal tanks or drums, in plastic containers or sacks. Plastic and metal containers sold for water storage make ideal grain stores but the grain must be very dry to prevent mould growth and mycotoxin production.

Farm storage structures may be relatively simple cylindrical, tightly woven baskets that may or may not be plastered with mud and/or cow dung; cylindrical or oblong mud brick stores; burnt brick structures with or without compartments, or ornate house-like structures. There is a wide range of storage designs and a variety of different materials from which they are fabricated, including sisal poles, tree bark, bamboo, twigs from various trees and grass twisted into rope; sawn timber; grass thatch and corrugated iron are used in roof construction. Designs vary in shape, diameter, height, longevity, cost, and in the skill required for construction.

Such storage structures must have:

- A roof with a overhang, which is sufficient to take rain water away from the grain, and provide shade to reduce diurnal temperature fluctuations that might otherwise result in night time condensation and wetting of the contents. Grass thatch provides excellent insulation but requires regular repair and needs to be renewed every few years. Corrugated iron sheets are much more durable and any temperature fluctuation they create inside the store can be minimised by painting white the external surfaces of the sheets. Cement tiles are both durable and poor heat conductors so meet both needs but tend to be expensive.
- A support structure that raises the container above the ground to prevent moisture entry from the soil. If the supports are long enough, at least 1 m, then rodent baffles can be fitted. Supports are best made of burnt brick but mud bricks or wooden poles will do, as long as precautions against possible termite damage are put into place. Wooden poles can be protected against termites by using commercial insecticide such as ben-

FIGURE 13 Farm storage structures




diocarb or by soaking or dipping the pole in used engine oil.

- A method of accessing the commodity in the store; this is usually achieved by having an opening or door in the structure or by raising the roof.

The quality and type of materials used in construction will determine the stores longevity. Raising the store above the ground will also enable the area around it to be cleaned and inspected for signs of termites, storage insects and rodent activity. Stores made from woven materials can facilitate aeration as long as the weave is not too tight. During periods of rain, stores can be plastered with mud to restrict water entry; the mud plaster also helps to prevent theft by animals and humans.

In some counties, farmers store grain in underground pits. These provide excellent security against theft. However, because they are impervious to ambient conditions and are not able to be aerated, grain placed in such pits must be very dry in order to prevent mould developing. Even so, some air usually does penetrate around the door of the pit, and it is not uncommon for condensation to occur on the surface layers of the grain, which do then go mouldy. It is important for farmers to be aware that grain near the surface of pits may well be contaminated with mycotoxin even if there is no obvious sign of mould decay.

Increasingly, producers are storing grain in sacks. These may be woven polypropylene (WPP), sisal or jute. Sacks may be stored in drying cribs or other purpose built stores but are frequently kept inside the house to improve security. To avoid moisture migration into the grain, sacks should never be stacked directly onto the floor. They can be stood on polythene sheeting, or raised off the ground on poles. It is also advisable

to ensure that a gap remains between the sacks and the walls so that they can be easily inspected and remedial actions taken if rodent or insect damage occurs.

Grain that is to be stored for several months, whether in a storage structure or in sacks, should be treated with insecticide to protect it against insects, which are the most common form of storage pests. This is best done by mixing the grain with a dilute insecticide dust, such as Actellic 2%, before the sacks or stores are filled. Insecticide is added and mixed in the same way as sand and cement are mixed to make concrete, a maximum of 50 kg being treated at one time. Dilute dust insecticides are cheap to buy and have the advantage of requiring no special equipment for application; a shovel is all that is needed.

In store

Grain can remain in store for a matter of days, months or for a year or more. Whilst in the store grain should be inspected regularly to ensure it remains in good condition and free from pest damage. Inspections should coincide with grain removals for food preparation, or when it is needed to brew beer, feed animals or removed for sale. Inspections should take place at least once a week.

The storage structure must also be inspected to ensure that it is in sound condition and has not sustained damage from browsing livestock and termites. Sacks must be inspected for holes made by rodents though which grain may be taken or spilt. The presence of rodents is often denoted by the presence of droppings on sack surfaces. The areas around the structures or stacks must be kept clean, swept and free of rubbish and other extraneous material to eliminate breeding sites. Sacks must be opened and grain examined for signs of mould growth and insect damage. Similarly, the contents of other structures must be observed with equal diligence.

Storing flour and compounded feed

The fine particles of flour are very attractive to water particles in the air. Dry flour stored for even very short periods will quickly become moist, the rate being dependent on the ambient conditions in which the sack is stored. Moist flour will allow fungal spores to germinate and very quickly a dense mycelium will become visible. Thus it is essential that flour is only stored for very short periods. However, small quantities can be kept safely in airtight plastic containers as long as the

FIGURE 14 **Entrance to underground storage pit**

FIGURE 15 **Sacks of grain stored in the house raised off the floor on poles.**

FIGURE 16 Mixing insecticide dust with grain for storage

flour fills the container, expelling the air inside; if the flour only partially fills the container then it could go mouldy.

Feed pellets similarly attract moisture so should only be stored for relatively short periods. Pellets are actually formed when water is added to them and this additional water is removed as the pellets cool down at the end of the process. If cooling is not fast the moisture present can permit mould development.

Flaked feed and other components that have a large surface area to weight ratio, such as wheat feed, bone meal and fish meal can all readily become mouldy if stored for too long, particularly in relatively humid conditions. Livestock keepers should only buy sufficient feed to last a maximum of 10 days; in some really hot humid countries even this period will be too long.

Silage and hay

Storage containers should be airtight. Mould problems only occur if silage is exposed to oxygen in air. This could happen at the periphery of the storage system, for example at the edges of plastic sheets used to cover the silage, especially if these are damaged in any way. Repairs must be made as quickly as possible and then the development of mould in aerobic conditions can be stopped.

More importantly, fungal spoilage can occur when silage is being fed out to livestock, as it is then constantly exposed to the air. Some spoilage at this time is, therefore, inevitable. However, to minimise this problem silage containers, pits and heaps should be kept relatively small so that they can be completely emptied in a relatively short time, 1-2 days. Thus it is better to have several small silage containers, which can be opened in sequence, rather than one large one that may result in significant spoilage.

The fungus *Penicillium roqueforti* has been identified as being the predominant fungus in different types of silage. This and other silage moulds, which include the *Aspergillus* and *Fusar-*

ium genera can be inhibited by additives that prevent aerobic conditions from occurring. Such additives include proprionic, benzoic and sorbic acids, and whilst commonly used in the developed world, are generally prohibitively expensive for use by small-scale farmers in the tropics.

Proprionic acid can similarly be used to inhibit mould growth in bales of hay whilst they are sweating and curing down by evaporation to safe moisture levels. Proprionic acid is sprayed onto the hay as it enters the baler and is commonly used in the developed world. Where hay is not baled but simply left as loose forage, mould development is restricted by simply allowing the hay to dry quickly.

DISPOSAL OF MYCOTOXIN CONTAMINATED GRAIN

Despite all precautions, it may happen that stored grain will become damaged by mould. It must then be assumed that the grain is also contaminated with mycotoxins.

If the farmer has plenty of grain in store, he can afford to lose a small quantity that has turned mouldy. Ideally, the farmer must discard

BOX 5 ACTION TO TAKE AFTER HARVEST TO REDUCE THE RISK OF MOULD CONTAMINATION AND MYCOTOXIN PRODUCTION

Drying

- Crop should be spread on a (black) polythene sheet, tarpaulin or empty sacks laid on the ground or on a concrete plinth.
- Unthreshed crop can be laid on platform or in ventilated crib to dry; cobs can also be tied in pairs and suspended from a vertical frame to dry.
- In wet or humid conditions crop should be artificially dried in a solar dryer.

Threshing, shelling , winnowing

- Handle crop carefully to avoid broken or damaged grain.
- Use hand or pedal operated threshers if possible.
- Avoid beating the crop with sticks as this creates lots of damage leading to mould development unless the grain is to be used quickly and not stored.

Storage

- Store unthreshed produce or grain in a suitable container which is raised above ground level. If the crop has to be stored on the ground ensure a suitable waterproof barrier is in place.
- Treat a crop that is to be stored for more than two months with a suitable grain protectant to prevent insect damage.
- Protect the crop against damage by rodents.
- External storage structures must have a good roof with suitable overhang to provide shade and to take away rain. They should be protected against rodents and termites. Access to the crop inside should be easily achieved by having an opening or door in the wall or a roof that can be raised.
- Sacks must be stored on a platform raised above the floor.
- Produce must be inspected regularly to ensure that it is free of mould, insect and rodent damage; if damage is present remedial treatment must be put into place.
- Flour and feed must only be stored for short periods to avoid mould development. Small quantities can be kept longer in airtight containers.

mouldy grain and any that is suspected of being contaminated with mycotoxins; this will include apparently clean grain that is in the vicinity of the mouldy produce. This grain should be burnt or buried.

Most farmers in the developing world, however, do not have a surplus they can afford to waste. It may well be absolutely necessary for the mouldy grain to be used, especially in times of sever food shortage. When this happens, mouldy and suspect grain must be diluted with a quantity of clean grain before it is used, the greater the dilution the better. Then this grain can be sold, used for brewing, or fed to animals.

If used as livestock feed it should be first fed to ruminants; ruminant microbes can detoxify some mycotoxins. Beef cattle should be fed before dairy cattle, and cattle fed before sheep and goats. Mature ruminants should be given the grain before growing and pregnant animals, and young stock should not be fed this grain if at all possible. Similarly, young chicks should not be fed contaminated grain or feed and mature birds should be fed before growing poultry. No suspected contaminated grain should be fed to ducks or turkeys as these are particularly susceptible.

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http://sacs.cpes.peachnet.edu/fat/Ergot.jpg Photo of ergot

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Mycotoxins are among the most potent causes of cancer. Ingestion through the diet can pose chronic health risks for both humans and livestock. Death may occur as a result of acute poisoning. Mycotoxins are chemicals produced by fungal moulds. These moulds grow during production, harvesting and storage of grain, pulses, nuts, roots and other crops.

This booklet is directed at the farm situation, providing advice that can be used to avoid mycotoxin contamination before food leaves the farm. The booklet describes what mycotoxins are, how they are produced and how to recognise signs of their presence. It provides advice to enable farmers to minimise the risk from mould contamination whilst the crop is growing, during harvest and through storage. Although aimed at farm situations, the booklet is intended to be used by extension personnel, both government and non-government employees, in their efforts to advise and assist the rural communities. A separate booklet addresses issues related to transport, marketing and urban consumption.