Large structures and objects are treated with HT, using steam heating systems to avoid the necessity of large electric power.

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07 - Five economic principles applied to stored product protection

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Abstract

Society has long recognized the critical importance of stored product protection for welfare of humans and domestic livestock. Economists note additional benefits in terms of more efficient resource use, facilitated trade, and market stability. Estimates of the stored product losses vary greatly but are large in aggregate and potentially economically devastating to individual enterprises. Economic principles can be applied to stored product protection to understand current practices and to indicate potential pathways to refine strategies for stored product protection. The appropriate selection of the adaequate method in stored product protection will choose the alternative that provides the greatest net benefits. Cost-benefit analysis is a powerful tool for rationalizing the resource allocation. The decision should focus on ”how much” or ”which one”. Economic threshold models offer insight into discrete choice problems. The good storage protection practice should recognize and deal with externalities. Protection activities may be driven by economic externalities and may themselves general externalities impinging on others. Economic theory discusses which goods should be provided privately and which publicly (by government). Economic theory identifies the circumstances where government supported research is sound policy. Minimize transactions costs to improve market efficiency. Contracts, voluntary industry standards, government regulations, and treaties, if properly formulated, can reduce transactions costs and improve commerce and trade.

Introduction

Society has long recognized the critical importance of stored product protection for the welfare of humans and domestic livestock. Protection technologies vary greatly across the globe. In some places protection technologies are very sophisticated and effective; in others losses are huge. Estimates of stored product losses vary greatly, but are large in aggregate and potentially economically devastating to individual enterprises (Grolleaud, World Resources Institute).

Economists note that successful stored product protection provides benefits beyond basic food security. Benefits include productivity gains from more efficient resources use, gains from trade, and market stability.

Economic principles can be applied to stored product protection to understand current practices and to indicate pathways to refine storage strategies. Five economic principles of general applicability are succinctly stated as: compare costs and benefits; model continuous and discrete choices; externalities exist; consider transactions costs; and public versus private goods.

Participants in the business of stored product protection are probably applying these principles. Presenting this information from the perspective of an economist may help storage practitioners refine their application. Each of these is now described more fully.

Compare Costs and Benefits: Cost-benefit analysis (CBA) is a powerful tool to guide decisions. All costs and benefits are quantified and monetized and the course providing the greatest net benefits is the preferred alternative. Benefits in stored product protection are the value of physical product at the end of the storage cycle for each storage regime. A baseline storage outcome is needed for making comparisons. Stochastic cost-benefit models can provide additional insights when certainty parameters can assume different values and there is some knowledge of the probability distribution of these values. Parameters that might vary include the initial pest pressure, efficacy of

treatments, and the product's value at the end of storage. Cost-benefit ratios are only helpful when the alternatives being compared either have identical costs or identical benefits. The important measure is the expected net benefits.

A related approach is cost-effectiveness analysis (CEA) which compares alternatives involving different costs and their outcomes measured in terms other than monetized value. CEA might be used when benefits are difficult to monetize or monetization is controversial, e.g., valuing extending a life. CBA appears to be more useful for questions of stored product protection.

Model Decision as Discrete or Continuous: The analytical models used are much different if the decision involves a variable that can assume a limited number of discrete values rather than a continuous range of values. The question is which action versus how much of a particular action. Optimization is generally straightforward calculation when deciding how much of an input to use, be it a chemical or a non-chemical alternative. In competitive output markets, the optimization paradigm is use an input up to the level that its value of marginal product turns negative. On the other hand, modeling the choice between a chemical based control strategy and a nonchemical strategy must account for preferences and ultimately subjective utility of the decision maker. Yes, cost-benefit analysis can rank a discrete alternative according to a maximum net benefits criterion. The shortcoming is that CBA does not explain the simultaneous existence of multiple discrete alternatives. Part of the answer is that firms and society consider values beyond what is typically captured in CBA.

Deal with Externalities: In economics an externality or spillover of an economic transaction is an impact on a party that is not directly involved in the transaction. Externalities can be positive (benefits) or negative (costs). A classic example of an externality cost is a train's smokestack emissions depositing soot on someone's laundry hanging to dry.

Fumigation of stored products means release of fumigants into the air. This might have immediate negative effects on neighbors if the exposures are high enough. Economists suggest various mechanisms to address externalities. One approach is for government to compel the source to compensate the injured third party or for the injured party to negotiate a payment from the source that is sufficient to cover the damages and possibly curtail the actions creating the externality. Another is to outlaw the activity that causes the externality. In the case of methyl bromide, the externality is the global ozone depletion which in turn impacts on human health but not just in the vicinity of the emissions. Compensating injured parties or paying the source to cease emissions is not practical. The Montreal Protocol addresses the externalities arising from the use of ozone depleting substances. Not every externality requires a multi-national treaty. Where the externalities are local, solutions such as buffer zones large enough to dissipate emissions on the source's own property can work.

Publically versus privately supplied goods: There is substantial economic theory regarding so-called public goods. I focus on a particular question that is still frequently debated. Which goods and services should be provided by the government and which by the private sector? Consider research, some research is very basic, costly, and takes many years. Such research may be risky in the sense that great effort may not result in discoveries leading to commercially viable products. Private enterprise may undertake similar research, but economists predict that relying entirely on the private sector would result in less than the socially optimal amount of research. Public subsidies, patent systems, and in some cases limits on liability, can encourage private research.

Private research tends to be applied research, that is, practical research with strong expectation of commercial success. Even here, venture capital looks for fast returns and protecting stored products probably does not attract a lot of investor interest.

Private firms have few incentives to develop things that can't be protected by patents, licenses, or trade secrets (propriety knowledge). Discoveries that are freely adoptable will provide the maximum social benefit, but the entity that devoted resources to the discovery won't be rewarded by the market. These characteristics points to the type of research that should be funded by the government.

In reality, there is no sharp division between the types of research funded by government and that funded by the private sector. Federal research such as the our host, the Julius Kühn-Institut, and the Agricultural Research Service in the United States have core research programs in basic research and elements of applied research of Stored Product Protection and Crop Protection and Quarantine. Private firms and governments both have interests in protecting stored products and in research that improves that protection.

Markets and the potential for profit determine the allocation of funds for applied research, but how does society ensure basic research is adequately funded? The short answer is it that it must happen within the political process.

Transactions Costs: Economic exchanges generally involve costs in addition to the purchase price of the commodity. In economics these are called transactions costs. The type of costs include search and information costs—finding out where you can get the services you want and who provides the service at the best price; negotiation costs—it takes valuable time to bargain over the price and other contract provisions; and enforcement costs—cost to make sure the other party performs as agreed in the contract.

When stored product protection involves contract services rather than doing everything internally, there will be transactions costs. The goal is to minimize these costs. Government and industry standards such as EPPO in contracts avoids negotiations cost over certain technical matters. Government licensing of suppliers to ensure minimum quality and recourse for poor performance, and infrastructure that makes market information readily available (directories and advertisements are examples) can reduce transactions costs. Search costs can be avoided by using a contractor who has proven reliable and affordable in the past. The more valuable in total the product being protected and the greater the price for say fumigation or packaging, the more willing you should be to engage in additional search. The economic principle telling you when to stop incurring search costs is marginal search costs should never exceed expected savings on the transaction.

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08 - Prospects for biological control of stored-product pests

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Abstract

Natural enemies are applied commercially against stored-product pests in Central Europe. In this contribution, an overview about the fields for application of the beneficial insects are given. The mode of action of beneficials is compared with the application of chemical pesticides. Examples for successful biological control include the retail trade, the food processing industry, storage on farms, bakeries and mills. Both conventional and organic producers apply beneficials. The main target pests are moths and beetles. Pest control companies gain in importance as operators of biological control. The prospects for biological control as a component of IPM is discussed.

Introduction

Do natural enemies exert stress on chemical products? Fewer synthetic chemical insecticides are available for the protection of stored products (Reichmuth, this volume; Arthur & Rogers, 2003). This leads to an increased interest in alternative control options, including biological control by mass-reared natural enemies that are now commercially available (Prozell & Schöller 2003). But does the availability of beneficials again result in a decrease of synthetic chemical insecticide application? To shed ligth on this aspect, three questions have to be adressed: (1) is there an overlap of fields of application of beneficials and chemical insecticides? (2) is the control effect comaparable? and (3) are there enough laboratory-reared natural enemies available to replace chemical insecticides? Let us first look at the main areas of commercial application to see if an overlap of fields of application exists.

The main areas of commercial application of natural enemies: In stored products, parasitoids are mainly applied against stored-product Pyralid moths and stored product beetles (Stengård Hansen, 2005; Schöller et al., 2006). The natural enemies are reared in the laboratory (augmentative release strategy) and released as pupae or adults in the target sites (Prozell & Schöller, 2003). Typically, inundative releases are advisable, i.e. relatively large numbers of beneficials are repeatedly released.

Control of stored product moths: Both parasitoids against stored product moths eggs and larvae are commercially available. Egg parasitoids of the genus *Trichogramma typically* have a fairly broad host range and attack the Indian meal moth, the Mediterranean flour moth, the warehouse moth as well as many other moths species. The egg parasitoids are usually released as pupae attached to egg cards at the rate of at least 500 females per linear meter of shelving, although higher release rates may be needed for situations where shelving is more than 2 m in height (Grieshop et al., 2006a). The individual *Trichogramma-wasp* is shortlived (2-6 days). Modern release units contain a mixture of developmental stages resulting in the staggered parasitoid emergence over a period of three weeks, or in the case of *Trichogramma evanescens* allow even the presence of egg parasitoids over 4 weeks. Given a release period in unheated storage buildings in Central Europe from mid of April to mid of October, a total of only 9 or 7 releases are necessary, respectively (Fig. 1).