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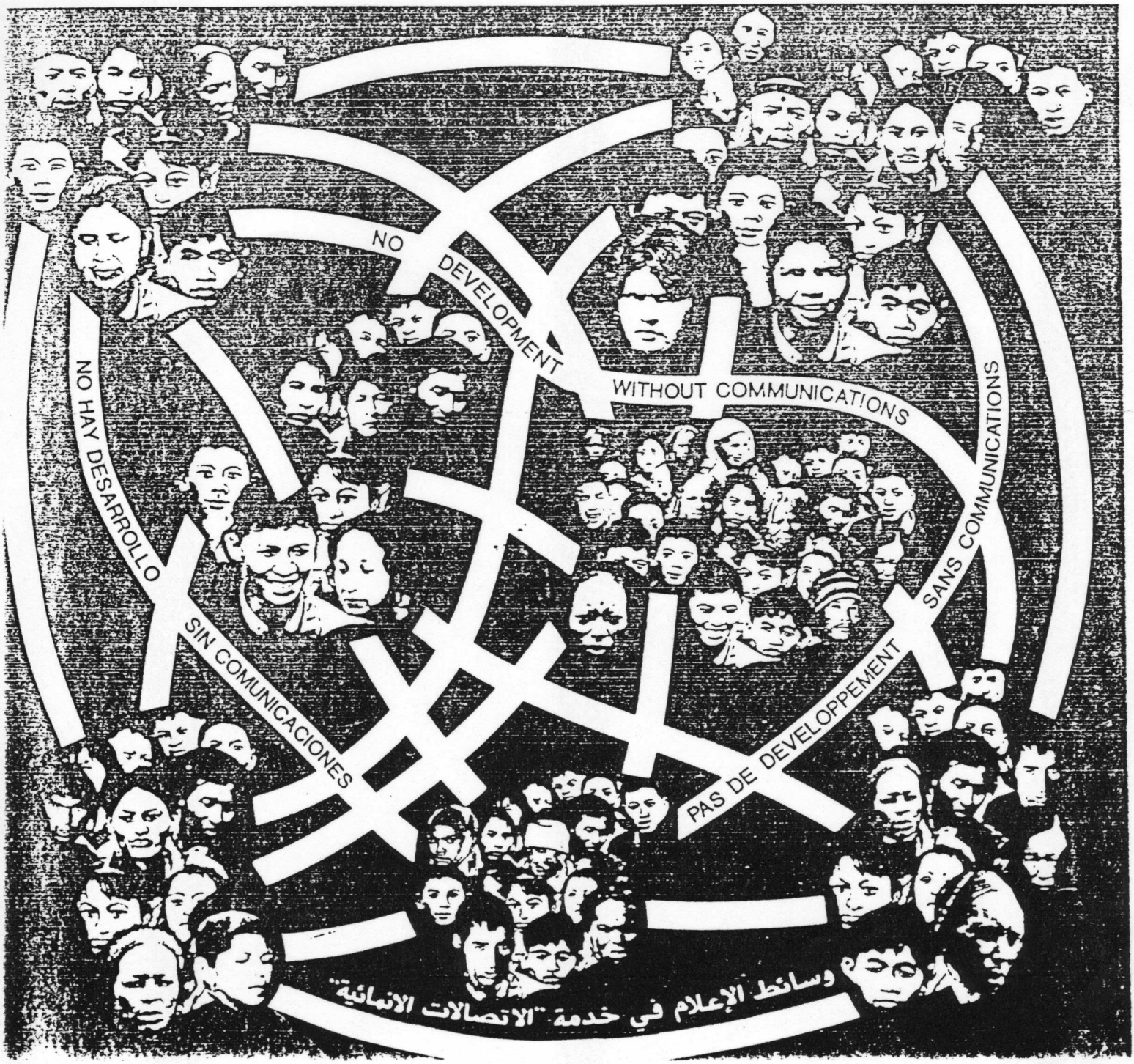

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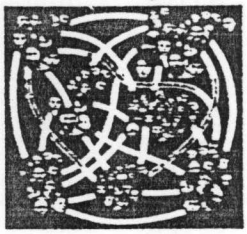

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PESTS WITH BACKBONES

by Donald J. Elias

When a layman thinks of the animal kingdom, he usually has in mind the three or four per cent of it represented by the vertebrates — horses, bears, or dogs as opposed to, say, beetles, worms, or jellyfish. But despite their minority status, vertebrates are a varied lot. They live on land or in water. They are warm-blooded or cold-blooded. Some fly, others swim or walk and run.

And most vertebrates — whether fish, birds, amphibians, mammals, or reptiles — can become "pests" when they enter into conflict with the interests or well-being of humans. Examples abound: when birds become hazardous to aircraft operations; when dolphins destroy the nets of commercial fishermen; when an exotic tree snake threatens the survival of indigenous bird species; when geese damage or foul golf greens; when rodents destroy works of art; when vultures prefer a vegetarian diet to carrion; when pigeons deface and accelerate the deterioration of buildings; or when vertebrates compete directly with man for food.

Vertebrate pests are responsible for limiting agricultural production. Although some species of animals which occupy limited geographic ranges cause only local problems, others, like vampire bats or several species of birds, which have a wide geographic distribution or are migratory, cause problems over extensive areas.[1]

Damage by vertebrates in agriculture — both direct and indirect — involves a variety of crops and animal species and can occur any time during crop development or postharvest storage. By direct losses is meant the actual destruction of food by consumption, contamination, or other means. Indirect losses are those that result from interference with the means of production, such as by damage to equipment or irrigation systems, the incapacitation of workers or animals by illness, and other similar problems. Forests, pastures, grain crops, stored products, orchards, equipment, and livestock are susceptible to damage by rodents. Birds, sometimes numbering in the millions, can wreak havoc on grainfields. Rabies, histoplasmosis, Newcastle disease, leptospirosis, plague, trichinosis, typhus, Chagas' disease, cryptococcocis, Eastern equine encephalitis, candidiasis, and chlamydiosis are only a few of the diseases, infectious to man or domestic animals, for which rodents, bats, or birds are major reservoirs.[2] Yet vertebrate pests have received a relatively small portion of the resources and expertise invested in agricultural development. Agriculturalists and others involved in food production have devoted vast amounts of time, effort, and money to insect control, for example, while vertebrate pests are largely ignored. Whereas most agricultural universities offer major programmes in weed science, applied entomology, or nematology, and other areas dealing with other kinds of agricultural pests, the universities that offer academic curricula in vertebrate pest management probably number less than ten worldwide. Only a few countries are attempting research on the problems despite the gravity of vertebrate damage in some areas and the potential for damage in others.

Bats as agricultural pests. Vampire bat parasitism on cattle and other livestock has long been a source of economic loss and hardship for livestock producers in Latin America. (See box.) These small bats have only one source of food — the blood of warm-blooded vertebrates, including man. They obtain it by biting open the skin to cause bleeding. Domestic animals (mainly cattle) are the primary victims. The transmission of paralytic rabies or possibly other diseases, blood loss, myiasis, and secondary infections all contribute to a problem that affects the livestock industries of about 21 countries. Paralytic rabies is considered the most serious animal health problem in Latin America and the vampire bat is the principal vector of the disease.

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Losses directly or indirectly attributable to vampire parasitism on cattle are estimated at US$350 million a year.[3]

Actual losses are probably even greater since estimates for livestock other than cattle (horses, swine, goats, poultry) are unavailable.

The group of large bats commonly referred to as "flying foxes" (*Pteropus* sp.) are widely distributed in southern Asia, Australia and islands of the southern and western Pacific Ocean and the Indian Ocean. They feed on fruits of various sorts, often congregating in an orchard where they can destroy a crop in a single night.[4]

Rodents as agricultural pests. Rodents are the most important group of vertebrate pests. So common is damage by rodents that it is often accepted as part of the normal scheme of things in agriculture. It is considered unavoidable and only minor attempts are made to evaluate damage, identify species, or attempt control. Crop losses to rodents and associated commensal rodent problems in the United States probably exceed $1 billion a year.[5]

Rice is probably the crop most severely affected by rodents, though damage to other crops may be of greater concern in some places. Rats have been held responsible for yield reductions of greater than 60 per cent in rice,[6] and rat damage has been reported as a limiting factor on rice production in some areas of the Philippines, to the extent of preventing successful production of crops during some parts of the year.[7] Maize, sorghum, millet, and wheat are other important cereal crops affected. Sugar cane is particularly susceptible to rodent damage, with the added danger that damage is often unnoticed or ignored. Direct damage by rats to sugar cane is often slight, but the rat's gnawing opens the rind and the ensuing fermentation dramatically reduces the sugar content with the result that often the entire stalk is lost.

Rodents cause severe losses in coconuts in almost all countries where they are grown. In the Comoro Islands, over 30 per cent of the total coconut crop is lost to rodent damage every year; losses as high as 77 per cent have been documented in coconut plantations of Colombia. Oil palm, cacao, and groundnuts are often seriously affected. Bananas seem to be especially susceptible to damage by geomyid rodents (pocket gophers), though other types of rodents may also be involved. Other fruits, garden crops, tuberous crops such as manioc, legumes, melons, squash, and even cotton may be attacked. Poultry, fish and young animals are not immune to predatory attacks by rodents.

Rodent damage to foodstuffs is not limited to standing crops. Considerable losses occur during post-harvest storage and transport. Cereal crops, which constitute the largest proportion of stored commodities, are the most prone to attack.

Rodents are reported as impediments to successful reforestation in many countries. In Chile, for example, *Octodon bridgesi* was described as the major pest in reforested areas.[8] Studies have yielded estimates of a 43 per cent incidence of damage and a tree mortality of one in eight in young plantations.[9]

While these few examples illustrate the severe impact that rodent pests can have on agriculture, the truth is that quantification of the magnitude of this impact is meagre at best. The

The recommendations of the FAO Panel of Vertebrate Pest Management in Asia and the Far East were:

1. Establishment of regional coordination for vertebrate pest management activities.

2. Improvement of information exchange through printed media and regular meetings of research and extension specialists in vertebrate pest management.

3. Encouragement of industrialized countries and international organizations to provide expert assistance, training opportunities, and appropriate commodity support for vertebrate pest management.

4. Development of graduate programmes in vertebrate pest management in the region.

5. Establishment of regional vertebrate pest management programmes to undertake research to develop strategies, methods, and materials to protect and ensure the benefit of gains made in agricultural production.

biology of only a few rodent species is well known; knowledge of most rodents is very limited. Some are known only from single museum specimens. Other species may be more common but basic information on their geographic and altitudinal distributions, preferred habitats, food habits, life cycles, and taxonomic relationships is lacking. This paucity of fundamental information impedes our efforts to define and resolve rodent pest problems. Some years ago, a report on the existing knowledge of rodent damage to crops and stored products in tropical and subtropical areas of the world concluded, "The one single fact which emerges most clearly from the survey is the widespread ignorance of the magnitude of the rodent problem, and means to control it."[10] Birds as agricultural pests. Farmers are generally indifferent to birds, though some bird species are valued for hunting or the assistance they provide in the struggle against weeds and insects. But a few species conflict with the farmer's interests and thus are regarded as pests. The damage caused by birds is often more dramatic than that caused by rodents because of the vast numbers of individuals often involved and the relatively short time span in which damage occurs, and because birds are much more visible than rodents. Various species of parrots and parakeets (Psittacidae), blackbirds (Icteridae), weavers (Ploceidae), doves (Columbidae), waterfowl (Anatidae), and seed-eaters (Fringillidae) are among the kinds of birds most often implicated in agricultural damage.

Birds most frequently attack grain sorghum, maize, and rice, but other crops attacked include wheat, soybeans, cacao, and many fruits. Standing crops are most vulnerable but losses of stored grain occur too, especially in village and urban areas where birds may roost in and around storage sites. Although they usually feed on spilled grain, birds often roost over the grain and contaminate the stores.

Data on crop losses attributable to birds are difficult to assess because damage is usually concentrated in limited areas and, due to the mobility of birds, is often seasonal, sporadic, and difficult to predict. In Africa, the red-billed quelea (*Quelea quelea*) ranges over 20 per cent of the continent and adversely affects the economies and food production capacity of 20 to 25 countries. Estimates of *annual* losses of cereals to birds range from at least $1 million in Somalia to $6.3 million in the Sudan.[11] Similar losses occur in Latin America.[12]

Challenges in vertebrate pest management. Vertebrate damage problems in agriculture are inherently complex and so is the development of solutions. Vertebrates, like other living things, offer their own unique challenges when they conflict with human interests and become "pests". These challenges result from the biological and behavioural attributes of the animals themselves as well as from the cultural, sociological, and political context in which they cause damage. Biologically, vertebrates are sufficiently long-lived to preclude genetic manipulations such as are sometimes possible for controlling insects, but not so long-lived as to preclude development of genetic resistance. Resistance to the anticoagulant rodenticide warfarin and related coumarin and indandione derivatives was first identified in the 1950s.[13] Such resistance has subsequently been documented in many areas around the world.[14] Vertebrate pests can be sedentary or mobile: rodents normally do not travel great distances while other vertebrate pests, particularly birds such as quelea and dickcissels, can and do migrate for hundreds or even thousands of miles.

Many invertebrate pests offer the biologist a reliably predictable fixed-action pattern or stereotyped response, but the vertebrates, especially rodents, exhibit learning and offer rapid and sometimes intraspecifically varied responses to biological or chemical insults. Conditioned food aversion is an example of such learning: when a rodent consumes a sublethal quantity of a toxicant and becomes ill, it associates the illness with the flavour of the bait and subsequently avoids it. Food aversion learning, a contributor to "bait shyness", is one area of investigation by vertebrate pest control scientists searching for ways both to overcome bait shyness and to find means of using the behaviour to induce aversion to the crops which the animals are damaging.[15]

Another contribution to the challenge of managing vertebrate pests is offered by cultural and sociological factors. Insects, weeds, and pathogenic organisms are not generally afforded religious protection, but in some developing countries rodents are regarded as both intelligent and vengeful. In some developed countries, concerns for animal welfare, humane treatment, and animal rights have extended to rats and noxious birds and the means used to control them. Such views can be of critical importance in the choice and public acceptance of effective strategies for management.[16]

Effects of agricultural development. It is a paradox that increasingly progressive farming practices and more technology-intensive agriculture seem to lead to concomitant increases in the complexity and intensity of vertebrate pest problems.

Efforts to increase agricultural production in developing countries involve environmental changes which appear to influence the types and extent of vertebrate damage problems. A principal means for countries to increase production is to bring new lands under cultivation by clearing forest, scrub, or marsh areas for agriculture. Outbreaks of rodent populations have often been associated with such disturbances of habitat and new farmers on marginal lands may suffer serious crop losses during the critical first years of cultivation. In addition, chronic losses may be accentuated when rodents move from adjacent uncultivated lands to exploit the available food sources in newly cultivated fields.[17]

Bird pests follow similar patterns. For example, one scholar considers the principal factors contributing to population outbreaks of eared dove (*Zenaida auriculata*) and agricultural damage in Argentina to be (1) the creation of a "mosaic pattern landscape" made up of thorns and croplands, offering both roosting places and an abundant food supply, and (2) the intensive sowing of sorghum which allows the existence of an important source of food during a long period of the year.[18]

Various approaches to increasing production on land already under cultivation also appear to cause agricultural vertebrate pest problems. Irrigation, which allows year-round planting in areas formerly dependent upon seasonal rainfall, brings changes in farming practices as well as changes in the behaviour of rodent and bird populations. Elimination of the natural scheduling of the planting season in agricultural areas no longer immediately dependent upon rainfall, coupled with the availability of high-yielding crop varieties with short growing seasons, often results in a more diversified system with crops of different ages in close proximity. Development of canals and impoundments creates additional favourable habitats.

Vertebrate control methods. If we consider vertebrate pest control in a broad context, we find that the methods used or proposed are numerous (see Table). A basic difficulty in the development of vertebrate damage control technology in many countries has been the tendency to underestimate the importance of species and environmental differences and to attempt translation of methods from the laboratory or from other geographical locations directly to the field where different species, crops, and environmental factors are involved.

Rodents provide a good example of this kind of failure. Most of the research and evaluation efforts in development of control methods have been directed toward the problems of commensal rodents in temperate cities and towns where the principal pest species is *Rattus norvegicus*. The private sector effort to develop rodent control materials and chemicals has been almost entirely directed at that market. Extension of rodent control techniques from the temperate urban situations in which they were developed to rural areas of the tropics has been generally ineffective.[19]

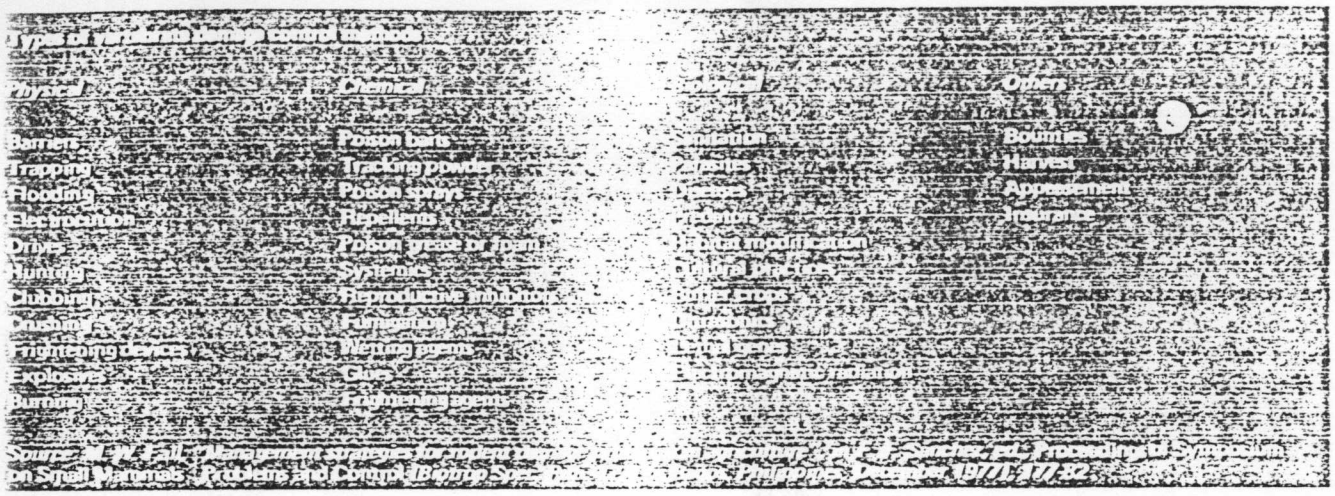
Vertebrate damage control methods used in an agricultural system must be effective within the bounds of funds available to farmers for crop production, and must have the potential of providing positive economic benefits in relation to cost. If farmers or plant protection agencies are expected to use particular control methods in operational situations, the methods must be evaluated in terms of efficacy in protecting crops and in terms of the total cost of crop protection. Additional considerations must include primary and secondary hazards to humans, domestic animals and non-target species, and environmental contamination.

Vertebrate pests and agriculture in developing nations. Contacts with agricultural personnel, reviews of available literature, and first-hand observations indicate that vertebrate depredations of agricultural crops occur throughout the developing world and are, in some situations, a limiting factor to agricultural production. Agricultural development processes, especially those which involve opening of new lands for agriculture, irrigation, and more

The bad reputation of bats results, at least in part, from a small group of South American bats called Desmodontidae, the vampires. Contrary to popular notion, these creatures do not grow as large as ravens, do not possess hollow fangs for sucking, do not usually victimize humans, and do not inhabit Transylvania or any other part of Europe. Their deal is to make sneak attacks on Brazilian cattle, delicately nipping open a vein with sharp front incisors and then lapping away at the flow of blood with a dainty tongue. Also, rather oddly, they prefer to land a discreet distance from the intended cow and make their final approach on foot, back hunched up high, tip-toeing over the ground like some bug-eared tarantula wearing a guilty look.

Here, I will concede, is a truly unsavory bat.

David Quammen, Natural Acts: A Sidelong View of Science and Nature (New York: Nick Lyons Books, 1985).



ntensive cultivation, appear to create nore favourable conditions for ver-ebrate pests, resulting in increased lepredations.

Most developing countries have nadequate vertebrate pest control programmes. Hence, except in a few solated cases, little organized and eliable information on the degree of lamage, the economic impact, or the pecies and crops involved is avail-ble. Control efforts are often limited o emergencies. Few attempts have een made to describe the problems, valuate the suitability of chemical or ther control agents, determine the elative effectiveness of different con-rol methodologies, or define other actors relevant to the problem of vertebrate pests. Often, inadequate materials or methods coupled with unsound application yield disappointing results. And when toxic materials are used, unacceptable hazards to humans, domestic animals, and environmental considerations are common because few of those persons responsible for crop protection in these countries have any training or experience in vertebrate pest control. Ideally, vertebrate pest control, like other forms of crop protection, should be considered an integral part of the agricultural production process. Unfortunately this is not the case. In 1973 a report by the FAO Panel on Vertebrate Pest Management in Asia and the Far East outlined the critical needs in vertebrate pest control in agriculture and made a series of recommendations. (See box.) While the recommendations were intended for a specific area, they are applicable to the situation worldwide, and many countries could benefit from adopting these approaches. Unfortunately they have not, and the recommendations are as valid and necessary today as they were when originally promulgated over 14 years ago.

Consider the recent rodent population outbreaks in the Sahelian countries of Africa which have been documented by representatives of several international development agencies including Deutsche Gesell-

schaft für Technische Zusammenarbeit (GTZ), USAID, and FAO. These are serious enough to have prompted requests for emergency assistance from two of the countries and the declaration of a disaster in a third.

Consider the damage that wild boars are doing on new croplands in the transmigration project areas of Indonesia. Consider the continuing losses of grain crops to quelea in Africa. Consider the losses of stored grains to rodents in Bhutan, Chile, the Dominican Republic, and elsewhere, or rodent damage to field crops in Syria and other countries of the Near East. Consider the damage to fruit crops by bats in Maldives and rodent damage to coconut plantations in Sao Tome.

Food production is controlled by a myriad of interlocking factors and forces. Vertebrate pests constitute a small but significant piece in this mammoth puzzle. Certainly, the prevention of losses to these pests would represent an important contribution to the alleviation of hunger problems in the developing nations of the world. However, rapid progress in improving vertebrate control programmes in the developing nations cannot be expected until the role of vertebrate pests in limiting agricultural production receives the attention it merits. Evidence from both developed and developing countries has repeatedly shown that expanded research and better application of existing technology are essential to alleviation of vertebrate pest problems. Long-term solutions to vertebrate pest problems in agriculture (and public health) will require increased emphasis on training in the public and private sectors and support for coordinated research efforts throughout the developing areas of the world.

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