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Rodents in the Tropics: Their Effects and Control

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Introduction

The damage caused by rodents in the tropics may be described as catastrophic or negligible depending on the source of the information. It is likely that the losses due to these mammalian pests is sufficient to be of significant importance to agriculture. This is true where investigations have occurred, but more knowledge is needed, and in order to get more information the Centre for Overseas Pest Research is currently conducting a survey of rodent damage (Anon., 1972). FAO and WHO are cooperating in this and are awaiting the results.

The control programmes for these tropical vertebrates are usually initiated with international assistance, and depend upon knowledge, organisation, training, extension, operation and evaluation. The operations must be continuous and all control elements must be continually updated.

Information needed

It is necessary to identify the rodents which are involved, the crops and agricultural products being damaged and to obtain a quantitative assessment of the damage as far as possible (Giban, 1967; Bentley, 1968); but these are only intended to be a prelude to more significant assistance. As a result of these and more lengthy surveys, knowledge is gradually increased. A recent article in *PANS* summarised considerable work, particularly regarding sugar-cane, rice and coconuts (Taylor, 1972).

In a survey in Egypt, five species of rodents from four genera were found to be involved in agricultural problems (Shuyler, 1970). The apparent role of *Rattus rattus* in these losses was unexpectedly great, and this may be the predominant pest species. The Nile rat, *Arvicanthis niloticus,* was not the most important species as was previously thought. This kind of information regarding changes in the 'species mix' may prove important in control, since Egypt is not the only country in which such modifications are suspected. In Egypt, it was found that nearly every crop was damaged at one stage or another. The losses were incurred in wheat (Egypt's most important crop), maize, cotton, cotton seeds, sugar-cane, rice, 15 other growing crops, prepared animal feeds, wheat flour and textiles. Destruction of sacks was high, and losses of chicks, eggs, pigeons and lambs were repeatedly reported. Rodent densities ranged up to 2380 per hectare in outdoor stores, and individual field crop losses ranged up to 80%. Rodent problems were reportedly at or near their peak during the survey. Overall losses to agriculture and its products in the areas surveyed were estimated at 4–5%. Though far from being the most desirable quantification, this kind of information can allow administrators to begin to weigh the cost of these losses against the probable costs of recommended control programmes.

Some instances call for the determination of rodent problems in a more limited sector of agriculture. Losses in rice in Thailand, for example, were ascertained to be caused by at least nine rodent species (Shuyler and Ratanaworabhan, 1970). Damage occurs throughout the rice crop cycle and in all post-harvest situations. The relative population densities of the various species was different in various parts of the country. Evidence indicated that rodent problems in rice were increased when coconuts, sugar palms or sugar-cane were growing adjacent to rice fields. Losses of rice caused by rodents in the areas studied were estimated at 5–6%. Rodent burrow systems were found to be quite common in the numerous termite mounds in and adjacent to rice fields, but in this limited survey only two species (both important pests) of the nine were recovered from the burrows. The collection of this ecological information during a species damage survey can be of value in formulating control programmes.

Reports of rodent problems regarding damage to numerous crops are received by FAO from many countries through several sources. Often the species of rodents involved are not known and the problems are described as serious, severe, causing considerable losses, constituting depredations, etc. Though helpful, these reports further point out the lack of quantitative information about rodent losses and the species causing them. This data is particularly needed to establish benefit–cost ratios in control programmes.

Some international assistance has research as its principal product (Fitzwater, 1967), since knowledge of behaviour, population dynamics, ecology and even life-cycles is not available for many important tropical species. For numerous species no studies have been conducted on their toxicological response to rodenticides. Research is also needed on materials which may enable the efficient use of bait toxicants. Some of the available knowledge is directly applicable or seems likely to be so, and this information must be disseminated (Rowe, 1968). FAO and WHO are jointly preparing bibliographies from 1950 to 1969 on rodent pest biology and control in order to assist rodent researchers and controllers to know what information is available. The work covering 1960–69 will be available shortly (WHO/FAO, 1972). But to know the scientific aspects of a rodent problem is not enough. Knowledge about social behaviour and beliefs, cropping methods, storage conditions, annual weather cycles and even medium-range climatic variations must be accumulated by the international specialist (Fitzwater, 1967; Rawnsley, 1969; Shuyler, 1970; Taylor, pers. comm). Without this type of information, recommendations for control programmes may prove quite inadequate and even impractical.

Organisation

The influence of private enterprise in rodent control is small in most tropical countries. Governmental organisations and private enterprise, to the extent that they are involved, must be appropriately structured for rodent control programmes to be effective. Though they overlap, the agricultural rodent problems are generally handled completely separately from those of public health. Within countries, cooperation between personnel of agriculture and public health is not always readily achieved; in fact the two groups may be unaware of the existence of each other, as was true in one country where their offices were only 200 m apart. At the opposite extreme, public health officials in another country must ask for and rely upon agricultural officials to initiate and conduct control measures to avoid human disease outbreaks. Organisation planning requires that the existing situation be taken into account and that the improvements needed are then instigated. FAO and WHO cooperate in agricultural rodent control programmes.

The organisation of agricultural rodent control is subdivided in some countries, with field crop problems being handled by a different group of personnel than those dealing with storage problems. Improved organisational planning would seem to be indicated in countries where rodent control is guided by personnel orientated towards human disease and conducted by people orientated towards animal disease; for example, this situation exists in one country where an industrial export crop suffers the greatest part of the rodent damage in that country.

Lack of adequate national government organisation and the resulting lack of personnel can tend to perpetuate a situation in which severe rodent damage continues without efforts to alleviate it. These gaps can even retard the development of requests for assistance; this is suspected to be the case in the Sudan zone of Africa, where rodent problems are considered by the governments to be of major importance (FAO, 1969).

The place of training

In the more developed countries of the world, there are too few rodent control specialists who are well-trained and have broad experience. This situation is even more pronounced in the developing world where it is often difficult to locate even one person who is reasonably adequately trained and can thus be expected to assume rodent control leadership. Persons assigned to rodent control positions are often chosen from among those trained in economic entomology or even nematology, and may have no background in mammalogy. It is obvious that a transition to rodent control is needed and on-the-job training is considered to be one of the most effective ways of initiating this. Fellowship training in Europe or North America is more likely to be meaningful after this period and is likely then to be a key element in the future success of the control programme. The specific information gained in fellowships abroad is often not directly applicable, but the principles underlying this information are important and useful. Fellowship trainees and those responsible for their training should keep these facts in mind.

As a part of training the wise international specialist will inspire his counterpart and assist him to pass this inspiration on to his fellow workers. This may be related to the general approbation and social standing extended to the rodent controller in most countries (Drummond, pers. comm.). A counterpart must be trained in the field by the international specialist and learn the importance of personally extending training to his immediate assistants and they to theirs, and so on. Laboratory operations are extremely important in many aspects of rodent control, but laboratory training will not take the place of personal knowledge of the field conditions in which pests live and cause their damage and an understanding of the people who suffer from these pests. There is reason to believe that six months' on-the-job training can produce an effective rodent control operative under proper conditions (Shuyler, 1972a) but researchers and administrators require longer training.

In-country training and fellowships abroad must be reinforced with continuing supplies of training material and appropriate technical literature. Training courses, such as those under the WHO/Denmark programme and those run by UNDP/FAO/Senegal in the Institute of Food Technology, and the Joint FAO/WHO Seminar (FAO, 1971) all contribute. Syllabi for training programmes are notably lacking for the developing countries, though some from the more developed world are helpful (Howard, 1969). It is primarily through improving organisations, funding and training that provision is made for adequate follow-up – an important, necessary function of international aid. In the final aspect of training the international component works itself out of a job, and gradually hands over to the local personnel.

Extension activities

The need to extend the knowledge of rodent damage, the fact that it can be controlled, and the specific control measures needed is even more important in developing countries than in the more developed countries (Shuyler, 1966). Most farmers, storage personnel and administrators will initially find it difficult to recognise the problem and its relative importance to agriculture and the national economy. If convinced, they will be sceptical that anything significant can be done. Thus, extension activities must aim upward within the hierarchy of government and society, as well as outward to the large numbers who directly need to know and use rodent control information. The techniques for each group are different and the effort must continue season after season. The techniques that can be used quickly ease the problems. Seeing a project at work also helps to convince the people concerned of the need to continue their support (Shuyler, 1966).

The techniques for large-scale extension differ little from those used in such fields as insect pest control or for rodent control in the more developed countries, but the relative importance of each method may vary greatly. For example, in several countries extension for farmers at first is by talks with individuals and small groups; later, posters which depend solely upon graphic wordless presentation of the facts may be needed. Specialists who are required to do this work must also be familiar with the culture of the country in which they are working. The radio is now an effective local, regional and national extension tool in most developing countries, but television is still primarily useful to convince the upper strata of society of the importance of the problem.

To speed the extension process, it is necessary to convince the opinion makers of the area to get them to demonstrate the validity of rodent control, and this is a most important task which pays high dividends. In one such instance, the copra crop increased dramatically by 270% only two months after the initiation of rodent control by an opinion maker with 300 coconut trees. This was sufficient to convince a neighbour who had 100,000 coconut trees to take the same steps (Shuyler, 1972a). Paraphrasing comments regarding rodent control (Drummond, pers. comm.), many of the problems are with people who do not know the importance of, or the methods for, rodent control.

Control operations

FAO generally can make the biggest contributions to the developing countries' economies per unit of manpower, time and money by first emphasising rodent control in agricultural products stores. This is because the products are concentrated in small areas and relatively small numbers of people need to be convinced and trained. The available technology is also more immediately applicable in storage situations than in fields.

For all agricultural rodent control the following elements are the minimum to be considered for integration into a control programme:

cultural practices,
exclusion,
biological control,
reductional measures,
other specialised operations.

In other words, rodents should be considered as populations of animals to be managed by multiple techniques so that the significance of their damage is reduced to that point at which the continuing losses do not economically justify additional activity to further reduce the damage. Various techniques may need to be emphasised at different times, but generally emphasis is important when populations are particularly vulnerable. To wait until damage is increasing rapidly is usually too late, though action may still be justified to save as much of a crop as possible.

Cultural practices are considered to be the most important although they are probably the most difficult control measures to introduce. Once introduced, they do not require scarce foreign exchange, are often permanently useful, cost users practically nothing and only need to be modified slightly to apply to many different crop patterns within the same ecological zone. Here almost all of the standard practices considered by economic entomologists must be included such as crop rotation, harvest dates and destruction of crop residues, as well as such things as the local practices within villages which affect rodent control, e.g. grain sanitation. The existing practice of using rodents as food in many countries must be examined to determine its utility in a total control programme.

Rodents may be excluded from an area of product storage in a relatively absolute manner (Tropical Stored Products Centre, 1970), which is referred to as rodent proofing or rodent stoppage; the latter phrase is to be preferred because it seems to imply less permanency and to allow the appropriate emphasis for continued inspection and maintenance. The banding, or sheathing, of trees to prevent rodent access to them and the trimming of trees, shrubs, hedges and vines are all included under the heading 'rodent exclusion'.

A rodent control practice which falls into both categories, i.e. exclusion and cultural practice, is that of creating and maintaining bare space barriers. A practice developed for use around advanced technology's food processing plants, etc., it is at least applicable around storage and high-value crops. A generally smooth, vegetation-free area, approximately 8 m wide, is maintained around the area to be protected, and this will greatly reduce ingress of rodents to that area, particularly if reductional techniques are used adjacent to the bare space. Note that the cultural practice of vegetation control advantageously utilises a rodent behaviour pattern which results in exclusion to a large degree; in the broad sense then, this is a biological control measure. Though not applicable where bund erosion is a problem, weed control which leaves bare bunds or dykes in rice (paddy) areas also tends to reduce their effective use as harbourage, burrow sites and highways for rodent travel. The electric rat fence is a very useful tool for protecting experimental crops or other agricultural products of high value (Anon., 1965; Rice Department Thailand, 1967).

Biological control is considered to be third in importance among rodent control techniques, though there is no proven method. The only one tested is one the author learned about from a religious group in the USA, and tried on a small scale in the Philippines, but where rabies occurs it may be less useful. With this technique, domestic cats are managed by conditioning them to a small, short, owner-provided meal in the early morning, a restful day in a cage with water, and a night of hunting in a garbage-controlled area (Shuyler, 1970). Rather wide variations were observed in predatory effectiveness, apparently related to the ability and temperament of the individual cats. A modification of this technique was observed to be in use in a large warehouse in Thailand. Knowing these variations in effectiveness and an earlier French effort to breed better rodent-hunting cats, perhaps a new attempt at this type of cat-breeding is in order, using today's genetic knowledge. Other possible biological controls are even more nebulous at present (Arafa, pers. comm.; Taylor, pers. comm.). Information available does not warrant the use of *Salmonella*, etc. and proposed sterilisation techniques, chemically or genetically induced, do not offer sufficient promise to developing countries at this time.

Reductional measures include trapping and poison baiting techniques. The author is probably the only rodent-controller experienced in the developing world who can say from personal knowledge that trapping can be an important part of continuing rodent control programmes. Its necessity in research is well known, and lip service is paid to its use in control programmes. Bait and trap shyness are known and may have been observed domestically.

In the Philippines, due to lack of funds, the author felt challenged to make trapping successful. Some pest control operators depend on trapping inside food-processing plants (National Pest Control Association, 1971; Thomas, pers. comm.), but there was a need to use trapping in a broad urban and rural community. Based on the British work pertaining to apparent memory of sub-lethal poisoning effects (Barnett, 1948) and by means of on-the-job testing, a scheme was developed which used different foods and types of food in a modified random sequence over a succession of 21 days before repetition. Used simultaneously with other measures, this resulted in data indicating that trap shyness was an insignificant factor (Shuyler, 1972b). Incidentally, the better trap baits are not necessarily among the better food materials for use in poison baits (Shuyler, 1954). Now in their fifth year, these programmes are still continuing in Dumaguete City, Philippines, and where adequate money has remained available trap shyness is apparently still insignificant (Café, pers. comm.). The other programme has had fiscal problems for about 12 months. Though some individual beneficiaries of the rodent control effort donate trap bait materials to the technicians, the pattern of consistent non-repetition for 21 days has been broken and trap-bait shyness to some more-frequently used baits has become significant within the past 11 months (Sun, pers. comm.). Since these are the oldest, continuing, successful rodent control programmes known in the developing world, means have been found to temporarily alleviate the financial stringencies.

In much of the tropics, trap baits, as well as poison baits, must be protected from immediate attack by insects to maintain their acceptability to rodents.

Poison baiting is the most well-known rodent control measure, but is only one of the many important techniques. Zinc phosphide is the only acute rodenticide which can be recommended for general use in rodent control programmes in the developing world. Compared with others, it has had a relatively excellent safety record during its years of use since 1911; however, even today too little is known about preparing highly acceptable baits with it, and about its fate in the environment. Other acute rodenticides can be recommended only where they can be used safely and when less hazardous materials are inappropriate. Bayer's Gophacide [*O,O*-bis(4-chlorophenyl)acetimidoylphosphoramidothioate] and crimidine show promise for use in the developing world (Swink, pers. comm.; Wichmand, pers. comm.). It is obvious that research and development of new rodenticides by private industry is an urgent need and WHO is encouraging such effort with the assistance of FAO.

The anti-coagulants as a group are available to the developing world, but it must be remembered that they are expensive and require foreign exchange. Perhaps of even greater importance, it is difficult to convince a farmer to take scarce food from himself and his family, mix it with rat poison, and then watch the rats eat it over a period of one or more weeks. The prospective end results have convinced some farmers, but many have refused to try it and still other large numbers of farmers have used it once and refused to consider its use again. (It is likely that these psychological problems would be increased in striving to introduce any use of chemical sterilisation techniques.) The use of poisoned water baits in tropical dry seasons has been inadequately explored. Reductional measures, particularly trapping and poison baiting, have been found to be most successful when used in a scheme quite similar to the principles of human warfare often referred to as 'defence in depth', and not as a 'frontal assault' or a 'last-ditch-defence'. Their success is enhanced when used as adjuncts to other management techniques in such a manner that the rodent population of the area is constantly under stress. Burrow fumigants and tracking powders (dusts) are examples of other reductional techniques.

The use of chloropicrin as a repellent in warehouses exemplifies 'other specialised control measures'. Rodents are not killed by its wick-release and it is not a cultural practice. Other repellents such as Philip's Rotran R-55 (chemical consituents unspecified) may be useful, for example in preventing mole rats from penetrating into underground grain stores. The list of other techniques is long; each has a limited specific use. All of the above types of control operations must be integrated not only with each other but with other good practices in plant production and protection, animal production and health, and with socio-economic patterns and human health needs.

It is to be understood that only non-emergency rodent control in the tropics can even approach the full scope of operations envisaged above. As in other pest outbreaks, when handled as an emergency such problems must be approached as though by firemen trying to put out the fire (Spencer, 1968). In emergency assistance the resources immediately available may not allow a sufficiently broad-scale approach to the research needed (Clark, 1958). In such an instance, assistance, including research, may be needed again later (Lavoie *et al.*, 1970). Sometimes, the doner and/or the international personnel assigned as a result of an emergency request are not satisified without at least a partial look at the long-term needs (Taylor, 1968; Wilson, 1971).

Evaluation

A well-structured programme of international rodent control assistance includes evaluation of all the results for their contribution towards effective rodent control. If research has been the main aspect, the research results and the estimation of the chances of the research information reaching the necessary people must both be included in the evaluation. If pilot control programmes have been conducted, they must be evaluated and their potential impact assessed. A pilot programme conducted in a government-controlled area is, almost *per se*, of less value in influencing the community than one conducted on privately owned or cooperative properties. A typical response of an individual in the former situation is that the Government can spend any amount of money; this is not personally applicable. In making the evaluation, the cultural, economic and climatic situation in the area must be considered. Costs of control should also be assessed: operational costs may initially be as high as 20–30% of the estimated losses, whereas the maintenance cost of a successful integrated control and management programme may be only 5–10% of its initial cost (Shuyler, 1972a). These figures compare favourably with those in developed countries.

Conclusion

The ideal has been outlined in the foregoing; but in order to achieve integrated rodent control in the tropics, it is necessary to improve on our knowledge and this particularly includes quantified information on rodent damage, an increase in the efficiency of the organisational structures concerned, the training of sufficient numbers of personnel to function within these organisations after the international personnel have left, the utilisation of organisations to effectively spread the message of the need for, and possibility of, rodent control and the creative utilisation of the knowledge available to gain significant reduction in rodent damage. The operations must use a well-balanced integration of rodent management techniques appropriate to the area. These will include cultural practices, rodent exclusion, biological control measures (where and when they are practicable), rodent reductional practices and other specialised techniques. When all of these things have been done, evaluation of the work will almost inevitably lead to the conclusion that the rodent damage is under control and that control can be maintained.

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