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ABSTRACT: The Secretariat for Rural Development of the State Government of Chiapas, southern Mexico, has been charged with conducting a campaign against the field rat which began in February 1991. Four areas were identified as key sites for the campaign benefiting 3,355 farmers in a total area of 8,000 ha and an initial budget of approximately $500m Mexican pesos (US $170,000). The major crops for which damage is reported are maize, sugar cane and cacao. The term "field rat" is a general one encompassing any rodent causing damage to field crops and in Chiapas probably covers a variety of species; no studies have been done to identify the species or quantify losses to crops. Personnel had no previous experience in rodent control and no resources to permit preliminary investigations in the field. A method for assessing field damage levels was developed and fields were treated with zinc phosphide (high damage), diphacinone (medium damage) or untreated (low or no damage). A decrease in subsequent losses was reported by farmers involved in the campaign. The campaign in 1992 is restricted by financial and logistic constraints as the field rat campaign has been united with locust and other field pests in a single campaign entitled "Control of Pests to Basic Crops" with a much reduced budget overall. Problems found in the 1991 work and the limitations and of the campaign are discussed.

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INTRODUCTION

In 1990 the Secretaría de Desarrollo Rural (Secretariat of Rural Development: SDR) of the State Government of Chiapas, southern Mexico, was charged with the field rat ("rata del campo") control campaign. This had previously been handled by the extension arm of the Ministry of Agriculture, the Secretaría de Agricultura y Recursos Hidraulicos (SARH) who had responded with a programme of broadcast baiting acute toxicants over the target area with little control over accidental poisoning or evaluation of their success. The SDR recognised that this approach is no longer acceptable, both ecologically and from the point of effective control and human and livestock safety. The decision was made to develop a campaign based on a monitoring programme emphasising minimal use of anticoagulant rodenticides applied with maximal effectiveness. Anticoagulants are now accepted as preferable in many agricultural situations (Marsh 1986) and it has also been shown that the use of the anticoagulant warfarin is more economic than an acute poison in Mexico (Martinez-Palacio et al. 1978). At the planning stage SDR personnel lacked experience in all aspects of rodent control and were faced with problems arising from a lack of knowledge available on the rodent pests concerned and the losses caused, as well as from the immensely varied nature of the agro-ecological environment in the state itself. Time, funding and personnel were not available to carry out the basic research necessary and the campaign was started at a very basic level with the idea of elaborating and refining it as experience and knowledge was gained.

CHIAPAS STATE

Chiapas state (74,000 km^2) lies in the extreme southwest of Mexico and can be divided into five broad zones: the coastal plain 15 to 35 km wide, the coastal mountains between 1,000 to 2,500m high, the central depression between 500 and 1,000m high, the central mountains between 2,000 and 3,000m high and the rain forest consisting of a rapidly decreasing area ca. 13,000 km^2 (see Figure 1). Chiapas is ethnically as well as ecologically rich, with 10 dominant ethnic groups comprising 20% of the total population, the majority living in the central mountain zone.

The states industry is almost entirely agricultural, with maize (the national staple crop), sugar cane, oil palm, bananas, coffee and cacao being the main crops; Chiapas is the third largest producer of maize in Mexico, with an overall production of 1,125,677 tonnes in 1989 and average yields of 1,790 tonnes/ha (Anon. 1991). The last four are principally grown in the coastal plain and maize in the highlands, in large-scale mechanised and irrigated systems in the central depression (with yields of 3-6 tonnes/ha) and at the small holder level under largely traditional practices in the coastal and central mountains (with yields of 1-2.5 tonnes/ha).

Highest rainfall occurs between May and October and maize is planted in May. At physiological maturity of the cob

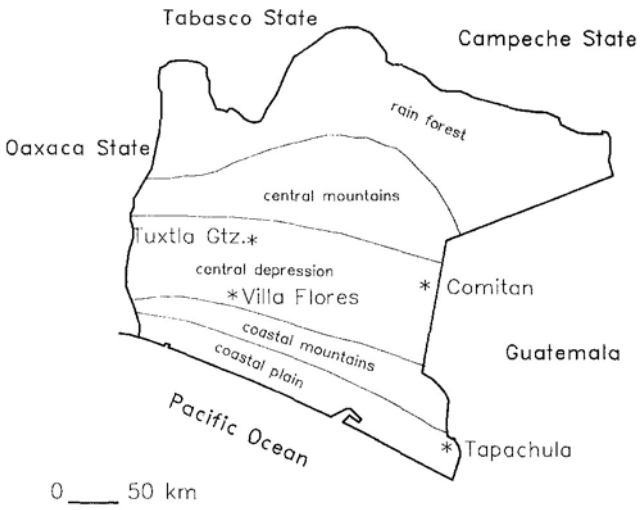

Figure 1. Chiapas State showing the five ecological zones and the administrative centres of the four areas (*) selected for the initial campaign in 1991. Tuxtla Gtz. = Centro, Villa Flores = Fraylesca, Comitan = Fronteriza, Tapachula = Soconusco.

plants may be cut and stacked in the field, or folded over at the point of cob attachment ("doubled") and left in the fields to sun dry for up to three months. Harvesting in terms of cob removal for storage occurs in December-January.

RODENT PEST SPECIES AND LOSSES FOUND

The term "field rat" embraces all small mammals which attack crops in the field and as such encompasses a range of species. No work has been done in Chiapas to identify rodent species present in the different zones, and limited work in the rest of Mexico (Mitchell et al. 1989). Species identified as pests by the SDR are *Rattus norvegicus, R. rattus* and *Sigmodon hispidus,* the last two in the coastal plain and the first generally. In the central depression and the mountain areas it is not known which species are responsible for damage; those known as pests in other areas which occur in Chiapas are *Heteromys* sp., *Neotoma* sp., *Oligoryzomys* sp., *Oryzomys* sp., *Peromyscus* sp., *Reithrodontomys* sp. and *Sciurus* sp. (Ceballos and Galindo 1984; Eisenberg 1989; Hilje and Monge 1988; Valencia undated).

The crop reportedly most affected by rodent pests is maize where cobs are attacked in the fields at the sun drying stage with routine losses of 20-30% and up to 50% as "common" (Ing. R. Vázquez G., SDR, pers. comm.). Some damage also occurs to planted seed and young plants. Other crops at risk are sugar cane (35-40% losses), cacao ("severe" damage), oil palm, fruit and vegetables (no figures). Coffee suffers from root damage by "tuzas," *Orthogeomys* sp.; comprehensive evaluations of losses to rodents have not been made and losses reported are subjective assessments only. In comparison, general losses to stored grain are estimated at 6 - 8% and primarily due to insect pests, secondarily to rodents.

From the geography and ecology of the state it can be seen that there is a potential for a varied and distinct species complex associated with different crops in different zones.

THE GUANAJUATO EXPERIENCE

The field rat campaign in Guanajuato in central Mexico is managed by the Sanidad Vegetal (Plant Health) division of the SARH. Guanajuato is smaller and far more uniform than Chiapas with an altitude between 1,500 and 1,800m and a generally dry climate. Maize is the major crop although the central valley is dedicated to the irrigated production of vegetables and strawberries.

Main pest species are *Sigmodon hispidus, Peromyscus* sp., *Rattus norvegicus* and *Mus musculus,* the latter two both as urban and rural pests; it is interesting to note that SARH personnel report an increase in occurrence of *R. norvegicus* in rural areas away from urban development. The main crop damaged is maize and damage occurs both to the young plant and to mature cobs at the sun drying stage when plants are stacked in the fields for periods of up to five months.

Campaign personnel focus on selected high-risk areas and follow systematic monitoring with rodenticide treatments. Fields are monitored in 10 ha samples following the methodology of Joule and Cameron 1974. Traps are left out for two nights and checked morning and evening; sites are sampled every three months. Post-monitoring action depends on catch and campaign personnel select between no further action, treatment with an acute toxicant or treatment with an anticoagulant rodenticide, as illustrated in Figure 2. The experience

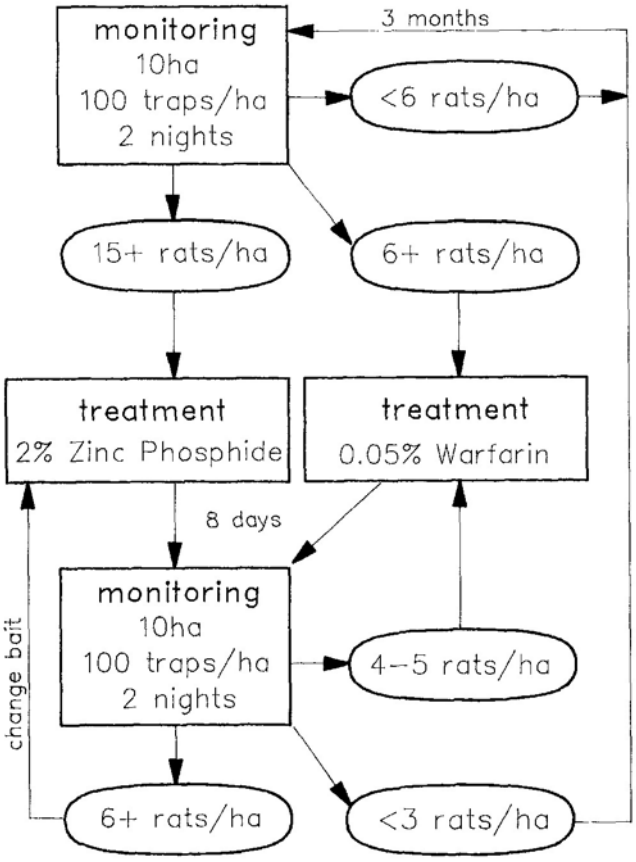

Figure 2. Sequence of events in the field rat campaign in Guanajuato.

of the technicians allows flexibility in the system depending on circumstances. This system has been found to be both effective and economical (Ing. R. Rodríguez, SARH Gto., pers. comm.).

CHIAPAS FIELD RAT CAMPAIGN: 1991

The emphasis of this phase was to build up experience and develop ideas, with a view to expanding and refining the campaign with each season. The Guanajuato system was seen as an ideal to aim for, although it was recognised that the relative complexity and richness of Chiapas would affect the final system evolved.

The campaign was started in February 1991 with a budget of $1,060m Mexican pesos (approximately US $350,000) for one year divided equally between the field rat and locust campaigns. Four initial high-risk areas were selected, Centra, Fraylesca and Fronteriza in the central depression and Soconusco on the coastal plain (see Figure 1), covering 15 municipalities with a total area of 8,000 ha and serving 3,355 farmers. Damage to field rats pre-campaign had been reported as "moderate" in the Centra and Fraylesca, and "high" in Fronteriza and Soconusco. In each area a campaign coordinator was nominated with four technicians under him, themselves supervised by a central coordinator based at the SDR offices in the state capital, Tuxtla Gutierrez.

Two baits were chosen for the first phase, 2% zinc phosphide and 0.005% diphacinone. Zinc phosphide was used for quick knock-down of populations in extreme situations; in areas of subsistence farming domestic livestock such as pigs

wander freely around the farms, often accompanied by children and risks of non-target and secondary poisoning are high. The anticoagulant diphacinone was selected for its low cost, the available formulation in wax blocks to resist the high humidity experienced (especially on the coast) and consequent ease of application, and also because warfarin was previously the toxicant most widely used by farmers in the area and the development of resistance was feared.

The success of the campaign was to be estimated by subjective assessment of damage levels by campaign personnel and farmers impressions of losses.

Methods

SDR personnel worked with 56 SARH Sanidad Vegetal groups in the target areas. Damaged fields were assessed by selecting five random areas within the field and examining a row of plants ca. 10m long, classifying each area as high, medium or low in damage. Field perimeters were examined for burrows and runs to identify points of entry and harbourage. Baits were placed outside burrows and in lines within and around the field, as appropriate and practical, at the areas of damage, baiting with zinc phosphide in fields of high and diphacinone in fields of medium overall damage, giving an average of 1.5-2kg bait/ha for both treatments. Visits were made to check baits at five (zinc phosphide treatment) or 10 (diphacinone treatment) days and the area rebaited if rodents were considered still active. A maximum of three treatments is allowed at any one area, following one or two treatments of zinc phosphide with one of diphacinone (see Figure 3). Fields were treated individually and no attempt was made to create a treated buffer zone.

Of the four areas only Centro and Fronteriza were treated in 1991, with a total of 365 kg of bait laid; damage experienced in Fraylesca was not found to be serious enough to warrant treatment, and despite high levels of damage reported in Soconusco no baits were available at the time due to distributional problems. In treated areas farmers and SDR personnel reported an unquantified decrease in rodent activity and subsequent crop damage; farmers were satisfied with the action taken.

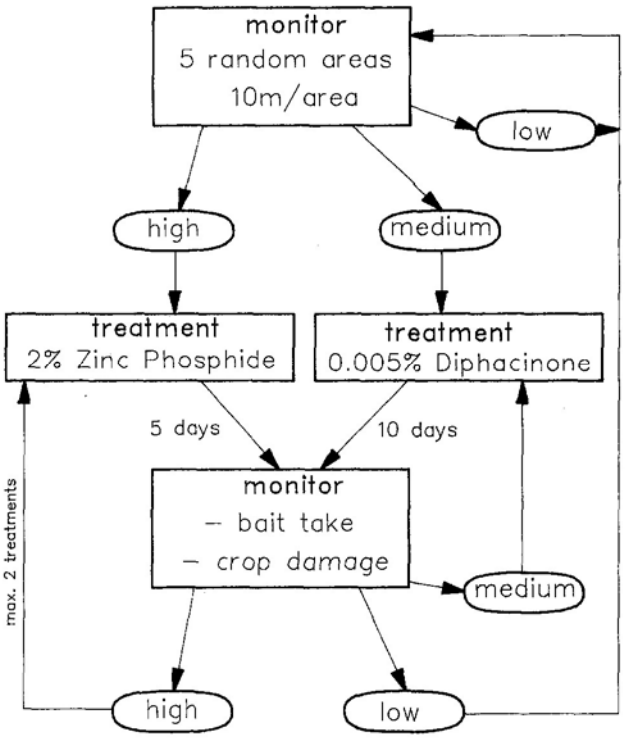

Figure 3. Sequence of events in the field rat campaign in Chiapas 1991.

CHIAPAS FIELD RAT CAMPAIGN: 1992

Original plans for the development of the campaign in 1992 included the purchase of break-back traps and the initiation of routine sampling in critical areas identified from the 1991 work. However, at the beginning of the year the field rat campaign was united with locust and other field pests into a single campaign entitled "Control of Pests of Basic Crops" with a total budget of $613m Mexican pesos, nearly half that of 1991. Personnel on the campaign are expected to deal with all field pest problems. This coincided with a serious outbreak of locusts in the north and south of the state and a considerable portion of the budget was consequently expended on this problem. The field rat aspect of the campaign has therefore been reduced to three regions, eliminating Soconusco which although suffering highest losses includes the lowest proportion of basic crops (e.g. maize) and so did not justify inclusion. A total of 10,985 kg of bait was purchased under the 1991 budget and not used; this has been distributed in the three areas for use in 1992.

Apart from financial constraints the high rainfall was found to be a major problem in baited areas, washing baits away either directly or by flooding of irrigation channels. Concern was expressed over the possible contamination of rivers and wells. It was also felt that baits were too exposed and that risks of accidental poisoning of non-target species were high, although no cases were reported. In 1992 personnel will use sections of bamboo as bait stations to improve bait protection; bamboo is readily available locally at negligible cost.

DISCUSSION

The major limitation to the campaign at present is that it is not preventative, unlike the Guanajuato campaign. Farmers normally only call in the assistance of the SDR when damage is extreme, losses are already high and use of acute rodenticides most justified. At this stage alternative food availability (i.e. the crop) is at its maximum and acceptance of baits of probably inferior quality lowest. Fields are treated as isolated units and the lack of a buffer zone implies rapid reinfestation from surrounding areas and short lived benefits from treatments. In this respect the campaign is still a long way from the goal of minimum toxicant use, which requires a comprehensive knowledge of the rodent population and losses caused, allowing preventative treatments to be made prior to the occurrence of serious crop losses as and when economically feasible. The need for basic research on the species concerned is emphasised but a major step towards this goal will be made with the start of routine monitoring with break-back traps in 1993.

A second development planned for 1993 is a change in anticoagulant bait to minimise the risk of the development of resistance, seen by SDR personnel as a major limitation in pest control campaigns in Chiapas. Sanidad Vegetal in Guanajuato formulate their own bait and pack them in waxed

paper throw-packs; this allows them to vary the formulation according to species and/or crop affected, use good quality bait bases to increase bait take, and is actually more economical than buying formulated baits (Ing. R. Rodríguez, SARH Gto., pers. comm.). Baits are placed in bait stations made from discarded engine oil tins. A similar system could be very effective using bamboo bait stations in the central mechanised maize producing area of Chiapas where rainfall is less extreme than on the coast and in the highlands.

An important cultural factor affecting the success of any rodent control programme in Mexico is the disposal of household waste. In rural communities there is no formal system of disposal and refuse, including kitchen and bathroom waste, is tipped into the streets and fields in and around the village. Such litter piles provide abundant food and harbourage for rodents and provide a bridge between field and domestic populations. Pigs also forage among the litter and in doing so may directly or indirectly act as a link for the transmission of rodent-bourne diseases from the field populations to man and domestic animals (Meehan 1984). A comprehensive campaign should therefore involve the entire community and include a considerable element of public education, an aspect not within the present capabilities or resources of the SDR campaign.

Combining all field pests as one campaign is seen in itself as a good thing as S DR personnel can respond appropriately to the farmers needs on the spot without having to refer to other campaigns with concomitant delays and increasing losses. However, in order to be effective an increase in resources is required, permitting the hiring of more staff, their training and travel costs and the purchase and distribution of agrichemicals. Training is particularly important in ensuring the effective use of toxicants; there is much unnecessary and incorrect use in the field leading to both resistance and contamination of the environment. The success of the 1992 campaign will be severely limited in all areas by the reduced budget and this will adversely affect production of probably most crops in the state and the subsequent revenue received. In a strongly agricultural state such as Chiapas the consequences are high of such limited investment in available resources.

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