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CHARACTERISTICS OF DAMAGE BY VERTEBRATE PESTS TO GROUNDNUTS IN PAKISTAN

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ABSTRACT: Vertebrate pest damage to groundnut (*Arachis hypogea*) was assessed at harvest in 164 fields selected along road transects in Pakistan. Overall damage in these fields was estimated at 5.3 %, of which the lesser bandicoot rat (*Bandicota bengalensis*) accounted for 2.4%, the short-tailed mole rat (*Nesokia indica*) caused 1.0%, and the wild boar (*Sus scrofa*) caused 0.9%. Desert hares (*Lepus nigricollis*), crested porcupines (*Hystrix indica*) and house crows (*Corvus splendens*) together accounted for the remaining 1.0% damage. The damage characteristics of each species are described. Observations indicated that visual above-ground examination of plants for damage underestimated the actual loss because both lesser bandicoot rats and mole rats often remove groundnut pods below ground without killing or otherwise damaging the plants. The yield loss based upon 5.3% damage would equal 67 kg of groundnut per hectare.

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INTRODUCTION

Groundnut (*Arachis hypogea*) is a major oilseed crop in Pakistan. It is grown as a cash crop by the farmers. The groundnuts are not used for oil, however, but are consumed locally, either fresh, roasted, or as nutmeats added to sweets. The area planted to groundnuts and its production peaked in 1984 (Pakistan MINFAC, 1986) when 72,600 ha yielded an estimated 88,000 mt valued at 686 million Pakistan rupees (US \$49 million) on the wholesale market at that time. About 70% of the total groundnut production in Pakistan occurs in rainfed (barani) areas in the districts of Attock, Chakwal and Rawalpindi in northern Punjab Province. Groundnuts normally are planted in sandy and sandy-loam soils. Sowing begins in April and harvest is in October. Some varieties mature in 170 days but others may require 200 days or slightly more. Plants sprout after sowing but then remain essentially dormant until the monsoon rains, beginning in July, trigger flowering and nut formation.

Vertebrate pest damage to groundnuts in Pakistan may begin as early as mid-July and continues until harvest 3 months later. Groundnuts are particularly vulnerable to attack by vertebrates because of this long maturation period. Also, because plant density is usually not very high (5,000 to 15,000 plants per ha), it is easy for vertebrates to damage considerable areas within fields in periods as short as 1 to 2 weeks. Very little quantified information on vertebrate pest damage to groundnut is published. There were references to damage by rats occurring in Senegal, Sierra Leone, Sudan, India, Thailand, East Malaysia, Tonga, and the West Indies but no quantified details were given (Hopf et al. 1976). Hoarding of groundnuts by *Rattus norvegicus* has been reported from Japan (Yabe 1981). In India, Bindra and Sagar

(1971) estimated average losses of groundnut yield due to field rats in three villages of 50 kg per ha. Previous data from Pakistan suggested that yield loss of groundnuts to rats and wild boar in Punjab and Sindh might be about 5 %, but sampling methods were not indicated (Roberts 1981).

The objectives of our survey of vertebrate pest damage to groundnut fields in northern Punjab during harvest were (1) to develop techniques suitable for assessing damage to groundnuts, (2) to quantify the damage and yield loss and their impact on groundnut production, and (3) to identify other factors that may have possible relevance to vertebrate pest infestations in groundnut fields.

METHODS

The groundnut fields were surveyed in early October 1986 by stopping at 5-km intervals along roads traversing the groundnut growing areas. At each stop, two fields along each side of the road were selected, one adjacent to the road and another about 100 m away from the road. Four quadrants were set in each field, usually near each corner. Ten to 20 paces were walked down the field border and then 10 paces were walked into the field to locate each quadrant. Quadrants measured 1 x 5 m in size. The number of damaged and undamaged plants, within each quadrant were counted. Damaged plants appeared either dead and dried or withered and dying. Other data recorded included groundnut variety (either erect or spreading), type of soil, presence of weeds and grasses, and the size of each field. Fields then were searched for characteristics from which the responsible pest species might be identified. The distance that rat burrow systems extended into the fields from the field edges or bunds was measured.

Additional observations were made beginning in early July 1986 of vertebrate pest damage to experimental groundnut plots at the National Agricultural Research Centre (NARC), Islamabad, and in farmers' fields at the village of Tharjial Kalan about 30 miles distance from Islamabad. Notes were made of the foods (weeds and grasses) that rats were utilizing in areas peripheral to the NARC groundnut plots and in farmers' fields.

We suspected that above-ground observations of damaged groundnut plots underestimated the real extent of the damage below ground. To test this, we sampled four quadrants of damaged and undamaged plants in groundnut fields at the village of Tharjial Kalam. Two quadrant counts (2 x 5 m²) were taken in areas of obvious rat activity, i.e., burrows, pathways, dead plants, and two were taken in areas of the same fields where there was no surface evidence of damage. After counting all the plants in each quadrant, the groundnuts from all plants were removed, bagged, air-dried, and weighed.

RESULTS

The survey revealed that seven vertebrate pest species were infesting groundnut fields. A description of the pests and their damage characteristics follows: Short-tailed mole rat

Mole rats (Nesokia indica) tend to live in the grass- and weed-covered bunds from which they invade the fields by tunneling outward, leaving a trail of burrow mounds as evidence of their presence. Forty-two percent (42%) of all mole rat burrows counted were within 1 m of the bunds and 65 % were within no more than 5 m into the fields. The burrow mounds tend to be clumped, with as many as 20 to 30 mounds within an area of 25 to 50 m².

Mole rats damage groundnuts either by eating the roots, which kills the plants, or by eating the groundnuts only, which leaves a live but unproductive plant behind. The burrow mounds of Nesokia rarely contained any eaten and empty shells of groundnuts. Nesokia mounds can be differentiated from bandicoot rat mounds by their generally smaller soil particles pushed up from the tunnels and by the more capsule-shaped fecal droppings mixed into the mounded soil.

Lesser bandicoot rat

Lesser bandicoot rats (Bandicota bengalensis) also live in burrows in the bunds and invade outward into the fields when the monsoon rains slacken. But, because they travel as much above ground as below, their mounds could occur anywhere. In practice, however, they generally stayed near the bunds and constructed mounds in clusters much like Nesokia. Their mounds were characterized by the larger soil particles, open burrows, visible runways, empty groundnut shells scattered about in the area, and spindle-shaped fecal droppings. In many cases, bandicoots had burrowed under groundnut plants and simply removed the nuts without killing the plants. Bandicoot rats do not occur throughout the groundnut-growing area; they are confined to the north and eastern parts that receive more rainfall and have more loam

in the soils.

Indian gerbil

Indian gerbils (Tatera indica) occurred in sandy soils in 11 fields. This species was never found in abundance in any field and it usually damaged only the individual plants under which it burrowed. The amount of damage it did was insignificant. Groundnuts were removed but the plant usually was not damaged. Eaten groundnuts looked like those of any other rat-gnawed shell.

Desert hare

Damage by desert hares (Lepus nigricollis) also was observed in 31 of the 164 fields. Hares did not damage the plants or roots but instead removed the nuts by pawing a shallow digging around the plant. They opened the shells much like rats, leaving empty shells scattered among the plants. Hare damage occurred throughout the fields. Fecal droppings in the fields, typical of rabbits or hares, were usually abundant.

Crows

Crows, both the house crow (Corvus splendens) and the mountain or jungle crow (C. macrorhynchos), generally cause damage in sandy areas where it is easy for them to pluck the groundnuts from the soil with their beaks. They usually do not dig more than 2 to 5 cm in the soil. Once they expose and remove a nut, they make a small hole at one side and extract the nuts without completely opening the shell. Shells in many cases remained attached to the plant. Crows can cause severe damage in sandy fields because they feed in flocks; each crow can eat the groundnuts from more than 20 plants in a few hours. Crow damage was seen throughout fields. Jungle crows normally do not descend to the plains until the first onset of cold weather, at which time most of the groundnuts are already harvested.

Porcupine

Crested porcupines (Hystrix indica) damage and kill the plants by clawing the groundnuts from under the roots. The damage extends into the soil about 2.5 to 7 cm, leaving loose soil under the plant, or an extracted plant. Intact, partially consumed, and empty groundnut shells are scattered about the clawed area. Damage usually occurred to a series of plants in a limited area, such as near a field edge, and as many as 30 to 40 plants may be damaged in one night. Porcupine presence was determined from their footprints, fecal droppings and nearby burrow openings.

Wild boar

The wild boar (Sus scrofa) roots out groundnuts from under the plants, generally scooping out a depression from 5 to 10 cm deep and as much as 30 to 40 cm in diameter (Fig. 1). Very few empty groundnut shells are found since the wild boar generally eats both shell and nuts. They prefer the groundnuts when they are soft and sweet, before the shells harden. Wild boar damage is more intense earlier in the crop

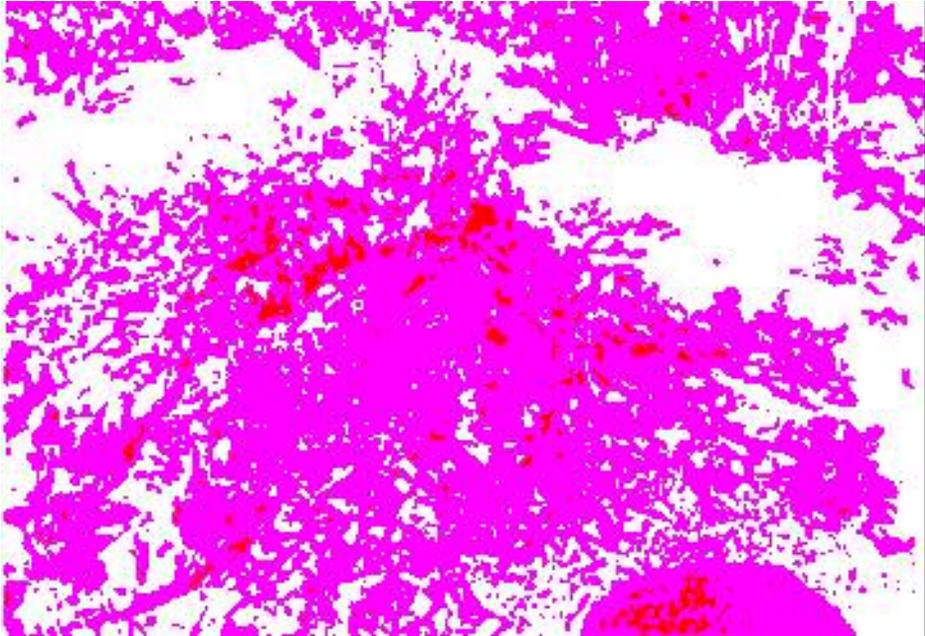


Fig.1. Wild boar (*Sus scrofa*) damage to groundnut plants.

cycle and slackens as the nuts mature. The trail of wild boar damage could often be followed from plant to plant through a field. On some plants, roots were exposed, and the plants were withering, dying, or were dead; on other plants, the nuts were removed but the plants were otherwise uninjured. One boar was seen to have damaged 65 plants in one night. Wild boar presence was easily identified by their tracks.

Damage Assessments

Rat damage to groundnuts began at NARC and at the farmers' fields in mid- to late July. Both the short-tailed mole rat and the lesser bandicoot rat were subsisting on the seeds of the grasses *Desmostachya bipinnata*, *Echinochloa colonum* and *Cyperus rotundus* and on the rhizomes of *D. bipinnata* and *Sorghum halapense*. prior to attacking groundnuts (Fig. 2). Several of these grasses were common in groundnut fields that we surveyed and rhizomes were frequently seen in the soil mounds of *Nesokia*. Rats subsist on these materials and supplement their diets with the groundnuts.



Fig. 2. Rhizomes of *Sorghum halapense* provide rats with subsistence food in groundnut fields.

We examined 164 fields at 41 sites just at harvest in the period 9-12 October 1986. Evidence of vertebrate pests was found in 140 fields (85.3%) and damaged plants were found in 125 fields (76.2%). The most abundant species was the short-tailed mole rat (69 fields), followed by the lesser bandicoot rat (42), wild boar (32), desert hare (31), porcupine (19), crows (11), and Indian gerbils (11 fields) (Table 1).

The most damaging species was the lesser bandicoot rat, which accounted for 2.4% damage to the 8,940 plants that were counted. The short-tailed mole rat had damaged 1.0% of the plants and the wild boar caused 0.9% damage. Desert

hares, crested porcupines and house crows together accounted for the remaining 1% damage. Total damage seen was 5.3% of all plants counted.

Plant density averaged 3.1/m² (range 1.1-7.9/m²). The higher plant densities were found in areas where erect varieties of groundnut were grown on loam soils. The

spreading varieties generally were grown in sandy soils and in lower plant densities. Lesser bandicoot rats appeared to be more frequent in fields with higher plant densities while short tailed mole rats appeared to occur more often in fields with lower plant densities (Table 2).

Table 1. Vertebrate pests and extent of damage to groundnut fields at harvest, October 1986 (damage based on 8,940 plants counted in 76.4 ha of fields).

No. fields	Damaged plants	
	Totals	%
Examined	164	--
With damaged plants	125	76.2
With evidence of vertebrate pests	140	85.3
With vertebrate species due to:		
Short-tailed mole rat (<i>N. indica</i>)	69	1.0
Lesser bandicoot rat (<i>B. bengalensis</i>)	42	2.4
Wild boar (<i>S. scrofa</i>)	32	0.9
Desert hare (<i>L. nigricollis</i>)	31	0.7
Porcupine (<i>H. indica</i>)	19	0.2
House crow (<i>C. splendens</i>)	11	0.1
Indian gerbil (<i>T. indica</i>)	11	--
	Total	5.3

Table 2. Relationship between groundnut plant density and presence of lesser bandicoot rats and naked mole rats in 164 fields.

Plant density (m ²)	Fields (No.)	% Fields with	
		bandicoot rats	mole rats
1.05 - 2.0	29	6.9	37.9
2.05 - 3.0	63	20.1	34.9
3.05 - 4.0	37	21.6	29.7
4.05 - 5.0	21	52.4	38.1
5.05 - 6.0	10	40.0	20.0
6.05 - >	4	100.0	0.0

The distances that rats penetrated from the field edges into the fields are given in Fig. 3. Lesser bandicoot rats tended to move away from the bunds and into the fields for distances of 10 to 20 m; 77.8% of all observations were from the bunds to 10 m. The maximum distance into a field was 28 m. Short-tailed mole rats had a different pattern of distribution; 42% of all mole rat burrows were within 1 m of the bunds (most were on the bund). There was no significant difference in the mean distance moved into the fields for the two species (t-test, P>0.05).

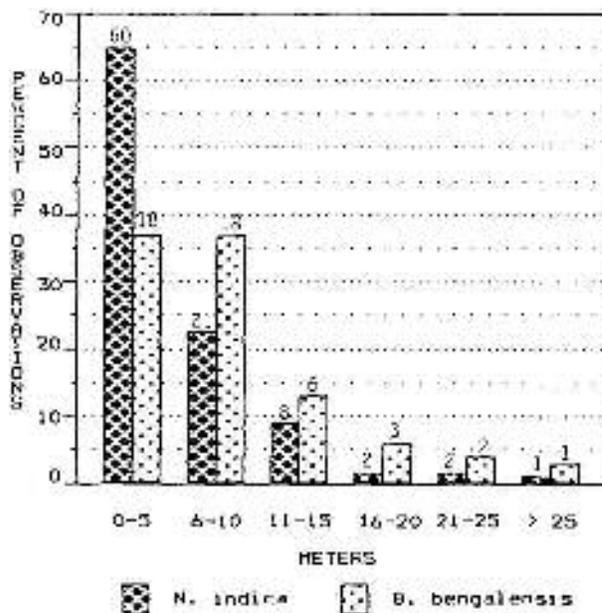


Fig. 3. Distance of rat burrows from bunds into fields (numbers above bars indicate sample size).

Data from fields at Tharjial Kala supported our contention that the above-ground quadrant counts were underestimating the loss of yield due to rat damage (Table 3). The average percent plant damage as determined from quadrant counts for the four fields was 21.6%, and the average difference in weight of groundnuts between the damaged and undamaged parts of the same fields was 38%. If the 5.3% overall plant damage, which we assume represents the same percent yield loss, is added to the 1984 production of 88,000 mt, the total yield could have been 92,900 mt. This loss to vertebrate pests of 4,900 mt is conservatively valued at 38,198,000 Pakistan Rs (U.S. \$2.94 million) in the 1983 wholesale market. Likewise, if the 5.3% damage figure is also applied to the 1984 average groundnut production in Pakistan of 1,212 kg/ha, yield losses would average 67 kg/ha, similar to the 50 kg/ha figure reported for Indian Punjab by Bindra and Sagar (1971).

Farmer Pest Control Practices

While they are active in groundnut fields, wild boars are difficult to discourage. Night guarding is a desperate attempt

to frighten them away but with little chance of real success. Nonetheless, many farmers who had to contend with wild boars had erected stands to hold charpoys (beds) in their fields. They spent nights for up to 2 months guarding these fields with lanterns, spears, dogs and noisemakers to frighten away the boars. Scarecrows also were used in attempts to frighten wild boar and rats from fields but with little success. A few farmers had procured zinc phosphide from local agricultural extension workers and made baits for rodent control.

DISCUSSION AND CONCLUSIONS

Farmers in Pakistan who attempt to grow groundnuts are faced with a multitude of pest problems and a long vulnerable period between flowering and early nut formation in mid-July until harvest in early October. Farmers lack effective methods for reducing rat infestations in groundnut fields. We found that treatment with 2% zinc phosphide bait blocks, followed with a bait of broken rice with coumatetralyl at 0.0375% (ppm) could eliminate rodents from experimental groundnut plots, but farmers cannot yet find these materials at village markets in Pakistan. They could use a reliable source of ready-made acute and chronic rodenticidal baits.

Table 3. Loss of weight of dried groundnut pods from rat-damaged and undamaged plots from four farmers' fields.

Field No.	Weight (kg/ha)		Percent weight loss
	Damaged plots (n = 8)	Undamaged plots (n = 8)	
4	1101	1190	7.5
5	628	1613	61.1
6	1025	1277	19.7
7	762	1592	52.1
Totals/ave.	3516	5672	38.0

Methods to assess damage by vertebrate pests in groundnut need further refinement and development. Above-ground counts of dead or injured groundnut plants appear to underestimate damage by burrowing rats. Because both species frequently remove only the nuts, leaving the plant alive but unproductive, surface observations do not reflect actual losses. Perhaps the technique in which plants from damaged and undamaged areas of fields are removed and observed in association with an index of rodent infestation could be developed.

Farmers should practice good weed and grass control in their groundnut fields. Removal of *Desmostachya* and *Sorghum halapense* from the fields in June and July could eliminate the rats' subsistence food supply, i.e., the rhizomes of these plants, and possibly prevent many rat infestations from spreading into the fields. Grass seeds probably play a minor dietary role.

The adoption of groundnut varieties with a shorter growing period (120-140 days) could reduce the time during which the plants are vulnerable to vertebrate attack-with one exception. These varieties, planted in July, are harvested in late October and early November. The mountain crow conceivably could be a serious pest of these monsoon-planted varieties.

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