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Rodent Pests in Agricultural Ecosystems: Biology, Storage, Damage and Economic Impact

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Abstract

Rodents are among the most destructive vertebrate pests affecting agriculture, stored products and public health worldwide. Their high reproductive potential, remarkable adaptability and omnivorous feeding habits enable them to thrive in diverse environments, causing significant quantitative and qualitative losses to agricultural commodities. The principal commensal rodent species responsible for storage losses include the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*) and house mouse (*Mus musculus*), while species such as the lesser bandicoot rat (*Bandicota bengalensis*), multi mammate rat (*Mastomys natalensis*) and Pacific rat (*Rattus exulans*) are regionally important pests. Rodents inflict damage through direct consumption of stored produce, contamination with urine, feces, hair and saliva, destruction of storage structures and transmission of numerous zoonotic diseases. Their continuously growing incisors, nocturnal behaviour, burrowing and climbing abilities and acute sensory perception make their management particularly challenging. This review summarizes the taxonomy, identification, characteristic features, biology, economic importance, major storage pest species and the nature and extent of losses caused by rodents. It also highlights the significance of integrated rodent management strategies involving sanitation, habitat modification, trapping, biological control and judicious use of rodenticides for minimizing post harvest losses, safeguarding food security and protecting public health. An integrated, environmentally sustainable approach is essential for effective long term rodent management in agricultural and storage ecosystems.

Keywords: Rodents, storage pests, post-harvest losses, food contamination, integrated rodent management, food security.

Introduction

Rats are medium sized, long tailed gnawing mammals belonging to the order Rodentia and family Muridae. They are among the most destructive vertebrate pests affecting agriculture, public health, and stored commodities worldwide (Bhairavi *et al*., 2024). Rodents

possess continuously growing incisors that enable them to gnaw on food materials, wooden structures, irrigation channels, electrical wires, and storage containers, thereby causing enormous economic losses (Chaudhary, 2024). Due to their remarkable adaptability, rats thrive under diverse climatic and ecological conditions and are distributed cosmopolitanly across tropical, subtropical, temperate, urban, and rural habitats. Depending on species, they may be arboreal, burrowing or terrestrial in nature (IGMRI, 2024). Rodents are highly prolific breeders with rapid reproductive potential. Most species attain sexual maturity within 2-3 months under favorable environmental conditions and females are polyestrous, exhibiting estrous cycles at intervals of about 4-5 days (Bhairavi *et al*., 2024). Their short gestation period, large litter size, and multiple breeding cycles per year contribute to rapid population build up, making rodent management extremely difficult in agricultural ecosystems (Chaudhary, 2024).Rats inflict serious damage both in the field and during storage. They consume grains directly and contaminate much larger quantities with urine, feces, hair and saliva. It has been estimated that rodents destroy or contaminate nearly 20 times more food than they actually consume (IGMRI, 2024). Important crops affected include paddy, wheat, maize, sugarcane, soybean, groundnut, pulses, gram, vegetables, and stored food grains. In India, chronic crop losses due to rodents range from 2-15%, while severe infestations may occasionally result in complete crop failure (Chaudhary, 2024). Apart from economic damage, rodents are important reservoirs and vectors of several zoonotic diseases affecting humans and livestock. They are associated with the transmission of more than 20 serious diseases including plague, leptospirosis, typhus, salmonellosis, rat-bite fever, trichinosis, and amoebiasis (Krishnan *et al*., 2024). Recent studies have highlighted the increasing importance of rodent-associated viral and bacterial diseases under changing climatic and ecological conditions (Viruses Journal, 2025). Because of their high reproductive capacity, adaptability, nocturnal behavior, neophobia and wide host range, rats remain one of the most difficult vertebrate pests to manage effectively (Bhairavi *et al*., 2024). Therefore, integrated rodent management strategies involving sanitation, habitat manipulation, trapping, biological control, and judicious use of rodenticides are essential for sustainable crop protection and food security (Chaudhary, 2024).

Identification of rodents

They are commonly found in and around residential buildings, warehouses, storage godowns, farms, gardens and open agricultural fields, where they obtain ample food, water and shelter (Chaudhary, 2024). “True rats” belong to the genus *Rattus*, which comprises several economically important commensal rodent species distributed worldwide (Bhairavi *et al*., 2024). Among them, the most common species associated with human dwellings and grain storage structures are the black rat (*Rattus rattus*), brown rat (*Rattus norvegicus*) and house mouse (*Mus musculus*). Other important rodent pests occurring in agricultural and natural ecosystems include the lesser bandicoot rat (*Bandicota bengalensis*), greater bandicoot rat (*Bandicota indica*), multi mammate rat (*Mastomys natalensis*) and Pacific rat (*Rattus exulans*) (IGMRI, 2024). These rodents are highly adaptive in nature and survive successfully under diverse ecological conditions due to their omnivorous feeding habit, rapid reproductive capacity and excellent burrowing

and climbing abilities. Their presence in fields and storage environments causes significant quantitative and qualitative losses to agricultural produce through feeding, contamination and structural damage (Chaudhary, 2024).

Characteristic Features of Rodents

Rodents possess several unique anatomical, physiological and behavioral characteristics that contribute to their remarkable adaptability and success as agricultural and household pests. Their high reproductive potential, efficient feeding habits and ability to exploit diverse habitats make them one of the most difficult vertebrate pest groups to manage (Bhairavi *et al*., 2024, Chaudhary, 2024).

Morphological Characteristics

- **Continuously growing incisors:** The most distinctive feature of rodents is the presence of a single pair of continuously growing chisel-shaped incisors in both the upper and lower jaws. These incisors grow throughout life and require constant gnawing to prevent excessive growth (Prakash & Mathur, 2014).

- **Diastema:** The incisors are separated from the cheek teeth (premolars and molars) by a wide toothless gap known as the diastema, which facilitates efficient handling and chewing of food materials (Bhairavi *et al*., 2024).

- **Self-sharpening teeth:** Rodent incisors possess a hard enamel layer on the anterior surface and relatively softer dentine on the posterior surface. Differential wear of these layers during gnawing keeps the cutting edges continuously sharp, enabling rodents to gnaw through wood, plastic, concrete, lead sheets, electrical cables, and even soft metals (Chaudhary, 2024).

Behavioural Characteristics

- **Nocturnal activity:** Most rodent species are primarily nocturnal, searching for food from dusk to dawn. However, they may become active during daylight hours when food is scarce or when population density is high (Prakash & Mathur, 2014).

- **High water requirement:** Most rats require daily access to water unless their diet contains sufficient moisture from succulent food materials. They can travel several hundred metres from their nests in search of food and water depending on resource availability (IGMRI, 2024).

- **Established travel routes:** Rodents generally avoid open spaces and prefer to move along protected pathways such as walls, fences, floor edges, foundations, pipes, rafters, overhead beams, and utility lines. These habitual runways provide protection from predators and facilitate efficient movement (Chaudhary, 2024).

- **Burrowing and climbing ability:** Many rodent species are excellent burrowers, while others, such as the black rat (*Rattus rattus*), are highly agile climbers capable of accessing roofs, trees and overhead cables (Bhairavi *et al*., 2024).

Sensory Characteristics

Poor eyesight but excellent sensory perception: Although rodents possess relatively poor visual acuity, they are highly sensitive to contrasts, movement, and light intensity. Their survival largely depends on their highly developed senses

of smell, taste, hearing, and touch (Prakash & Mathur, 2014).

- **Navigation using whiskers:** Long facial whiskers (vibrissae) and guard hairs serve as tactile organs that enable rodents to navigate efficiently through dark and confined spaces while detecting nearby obstacles (Bhairavi *et al*., 2024).

- **Neophobia (fear of novelty):** Many rat species exhibit temporary neophobia, showing extreme caution toward unfamiliar objects, foods, or environmental changes. This behavioural trait often reduces the effectiveness of newly introduced traps and baits during the initial stages of rodent control programmes (Chaudhary, 2024).

Ecological Adaptability

Omnivorous feeding habit: Rodents consume a wide range of foods including cereals, seeds, fruits, vegetables, insects, meat, and stored products. This omnivorous feeding behaviour allows them to survive under diverse ecological conditions (IGMRI, 2024).

- **High adaptability:** Rodents readily adapt to urban, rural, agricultural, and forest ecosystems. Their ability to exploit different habitats, rapid reproductive rate, and behavioural flexibility make them among the most successful vertebrate pests worldwide (Bhairavi *et al*., 2024).

Rodents as storage pests

Rodents are among the most destructive vertebrate pests of stored agricultural commodities worldwide. Rats and mice belonging to the family Muridae are responsible for substantial quantitative and qualitative losses in stored grains, pulses, oilseeds and processed food products. Besides consuming food, they contaminate much larger quantities with urine, feces, hair, saliva and pathogenic microorganisms, rendering the produce unsuitable for human consumption and reducing its market value (Chaudhary, 2024, IGMRI, 2024). Their persistent gnawing behavior also damages storage structures, packaging materials, wooden fixtures, electrical wiring and machinery, resulting in significant economic losses. Among the numerous rodent species, three commensal species are recognized as the most important storage pests throughout the world due to their close association with human habitations and food storage facilities (Prakash & Mathur, 2014).

Major rodent species infesting stored produce

Black rat or House rat (*Rattus rattus*):

The most widespread commensal rodent in tropical and subtropical regions. Excellent climber and commonly found in warehouses, grain stores, roofs and upper floors of buildings. Feeds on cereals, pulses, fruits, vegetables and processed food products. Causes severe contamination of stored commodities and damage to packaging materials (Bhairavi *et al*., 2024).

Norway rat or Brown rat (*Rattus norvegicus*):

Predominant in temperate regions but now distributed worldwide. A strong burrower that inhabits basements, drains, warehouses, godowns, and underground burrows. Consumes large quantities of stored grains and causes extensive structural damage through burrowing and gnawing (Chaudhary, 2024).

House mouse (*Mus musculus*):

Small but highly destructive commensal rodent found in houses, food processing units, laboratories, and grain storage facilities. Requires only small quantities of food but contaminates considerably larger amounts with droppings and urine. Due to its rapid breeding and ability to enter through very small openings, it is one of the most difficult storage pests to control (IGMRI, 2024).

Multi mammate rat (*Mastomys natalensis*):

A major storage and field pest in sub Saharan Africa and parts of the Middle East, causing severe losses to cereals and other stored agricultural commodities (Bhairavi *et al*., 2024).

Lesser bandicoot rat (*Bandicota bengalensis*):

One of the most destructive rodent pests in South and Southeast Asia, particularly in India, Bangladesh, Sri Lanka, and Pakistan. It causes heavy damage to both field crops and stored grains through feeding and burrowing activities (Prakash & Mathur, 2014).

Pacific rat (*Rattus exulans*):

Widely distributed in Southeast Asia and the Pacific Islands, where it damages stored food, plantation crops and field crops, especially on islands (Bhairavi *et al*., 2024).

Damage and losses caused by rodents

Rodents are responsible for substantial quantitative and qualitative losses of stored agricultural commodities throughout the world. The damage caused by rats and mice extends beyond direct food consumption and includes contamination, destruction of storage structures, damage to packaging materials, transmission of diseases and deterioration of stored products. In many situations, losses resulting from contamination greatly exceed those caused by actual feeding (Frantz, 1988, Chaudhary, 2024).

Direct feeding losses

Rodents consume considerable quantities of stored food grains, seeds and animal feed throughout their lifetime. Adult rats consume food equivalent to approximately 7-10% of their body weight daily. Thus, a rat weighing about 250 gm can consume approximately 15-25 gm of grain per day, amounting to 5-8 kg annually (Prakash & Mathur, 2014). House mice consume approximately 10-15% of their body weight each day. A mouse weighing 25 gm typically consumes 3-4 g of grain daily, resulting in an annual consumption of approximately 1.2-1.5 kg (Bhairavi *et al*., 2024). Although direct consumption appears relatively small on an individual basis, the cumulative losses become enormous because of the high reproductive capacity and large populations of rodents in storage facilities.

Contamination of stored produce

The greatest economic losses arise from contamination rather than direct feeding. Rodents contaminate stored grains and food products with urine, feces, hair, saliva and nesting materials, making them unfit for human consumption. It has been estimated that rodents contaminate 10-20 times more food than they actually consume (Frantz, 1988, IGMRI, 2024). Once contamination occurs, removal of urine stains, fecal pellets, hairs and pathogenic microorganisms is often impossible. Consequently, heavily infested grain lots are

frequently downgraded or condemned, resulting in substantial financial losses.

Damage to storage structures and packaging

Rodents possess continuously growing incisors that require constant gnawing. Consequently, they damage, gunny bags, paper sacks, plastic containers, wooden boxes, warehouse doors, windows, floors, wooden partitions, electrical wiring and insulation, water pipes, PVC fittings, plastic materials, furniture, books, clothing and important documents. Such damage not only increases repair costs but also creates additional entry points for moisture, insects and other storage pests (Chaudhary, 2024).

Structural damage

The Norway rat (*Rattus norvegicus*) is an excellent burrower capable of excavating extensive tunnel systems beneath warehouses, buildings, roads and storage platforms. Continuous burrowing weakens foundations, damages concrete slabs, irrigation embankments and drainage systems. Their strong incisors can even gnaw through soft metals such as copper and lead, in addition to wood, plastic, rubber and electrical cables (Prakash & Mathur, 2014).The black rat (*Rattus rattus*), being an agile climber, frequently inhabits roofs, attics and upper sections of buildings, where it damages roofing materials, insulation, electrical wiring and stored commodities while constructing nests.

Damage to agricultural produce

Besides damaging stored commodities, rodents attack crops in the field before harvest. They feed on cereals, pulses, oilseeds, vegetables, fruits, sugarcane and plantation crops, thereby reducing both yield and quality. They also damage ornamental plants, nurseries and kitchen gardens by feeding on seeds, seedlings, roots, stems and fruits (Bhairavi *et al*., 2024).

Public health hazards

Rodents are important reservoirs and carriers of numerous zoonotic diseases affecting humans and domestic animals. They are known to transmit more than 50 diseases, either directly or indirectly, including, leptospirosis, plague rat bite fever, salmonellosis, typhoid and paratyphoid, trichinosis, murine typhus and hantavirus infections. Contaminated food and water serve as major sources of infection, posing serious public health risks, especially in grain storage facilities and food processing establishments (Krishnan *et al*., 2024).

Indirect economic losses

Rodent infestations result in several indirect losses, including increased expenditure on pest management and sanitation, repair and maintenance costs of buildings, machinery and electrical installations, downgrading or rejection of contaminated grain consignments, reduced market value and export quality of agricultural produce, increased risk of fire hazards due to damaged electrical wiring, losses associated with disease outbreaks in humans and livestock. Overall, the economic impact of rodents is often much greater than that caused by direct feeding alone, emphasizing the need for effective integrated rodent management in storage systems.

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