

ASSESSING THE EMERGING HAVOC OF SNAILS AND SLUGS ALONGWITH THEIR MANAGEMENT IN RUPANDEHI AND NAWALPARASI DISTRICTS OF NEPAL

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ABSTRACT

Among 100 Terrestrial snails and slugs found in Nepal spanning 42 genera and 24 families, the Giant African Land snail stands out as the most destructive pest of vegetable crops in tropical and subtropical regions. A comprehensive study, involving direct observations and a questionnaire survey was conducted from 12th June to 2nd July 2023. The findings, based on responses from 141 participants, reveal a significant surge in snail and slug populations over the past 4-8 years in two districts. Based on these informants the most preferred habitats in the study area include gardens followed by bari (Small field), roadside, riverside, and water sources. The survey study in Rupandehi and Nawalparasi indicates that the majority of respondents do not observe snails and slugs throughout the year. However, their prevalence notably increases during the rainy season, from June to September. The Giant African Land snail was reported to be more prominent than slugs and horntail snails in both districts. These pests were found in various habitats, including gardens, bari, walls, roads, and paddy fields (referred to as Khet), with the highest number of sightings in gardens and bari. Respondents reported that they feed on a range of vegetable crops, including cucurbits, Cole, brinjal, okra, and taro, and cause 50% damage to nursery seedlings. The most common management practices reported include collecting and disposing of them in garbage-carrying vehicles, nearby rivers, and roads as well as crushing live individuals, spreading salt on them, and spraying alcohol and detergents. Regarding predators, respondents from Rupandehi identified the Greater coucal as the most prominent predator of GALS and slugs, while in Nawalparasi, the Great egret was reported to be the most common predator of snails and slugs. Only a few respondents from both districts used molluscicides such as metaldehyde and pesticides like cypermethrin to manage the snail and slug populations.

Key words : Gastropods, giant African land snail, snail, slugs, invasive species, Mollusca

INTRODUCTION

Snails and slugs belong to the Mollusca family. In Nepal, approximately 100 terrestrial snail and slug species from 42 genera and 24 families have been reported. The primary distinction between snails and slugs is the presence of a shell in snails, which offers protection against predators, while slugs rely on other means to evade threats. Both leave a slimy trail as they move. Among these, the African giant snail (*Achatina fulica*) stands out as one of the most destructive pests in subtropical and tropical regions, causing extensive damage to kitchen gardens, farms, and vegetable gardens (Jha, 2019). It is found in various environments, including urban settlements, kitchen gardens, agricultural lands, forest edges, riverbanks, shrublands, riparian zones, garbage deposits, wetlands, and hiding places, where they reproduce rapidly. Giant African land snails feed on over 500 varieties of plants (Ramdwar, M. *et al.*, 2018), causing significant economic losses in Nepal (Budha & Naggs, 2008). Snails were introduced to Nepal from India in the 1930s and have since spread widely in the Terai region from Jhapa to Kanchanpur (Budha & Naggs, 2008). Managing established snail populations is challenging, as they can thrive in harsh conditions between 2 to 30 degrees centigrade. Notably, they are absent in Kathmandu, despite the occasional transportation of eggs with vegetables and crops from snail-prevalent regions. Research by Budha and Naggs (year?), suggests that these snails establish themselves through pipes and water channels. A pressing issue in kitchen gardening is snail infestation, which can devastate crops such as cauliflower, cabbage, spinach, cucumber, pumpkin, bottle gourd, potato, radish, and tomato. Pests reproduce rapidly, making it difficult to protect crops once they establish themselves in an area (Dreistadt *et. al.*, 2016). Despite the economic losses in agriculture, snails can serve as a nutrient source in fish and pig farming. Research indicates that snails are a valuable food source for fish, and their flesh is consumed by pigs, poultry, ducks, crows, and more. In Nepal, farmers typically resort to local control measures when dealing with infestations, involving the collection and disposal of snails in nearby bodies of water or on roads to be crushed by passing vehicles. Additionally, some farmers use salt to eliminate snails (Jha, 2019).

MATERIALS AND METHODS

The research was conducted in Siddhartha Nagar Municipality, and Omsatiya Rural Municipality in Rupandehi district, whereas in Nawalparasi district, Ram gram Municipality and Pali Nandan Rural Municipality were selected for study.

Sample and sampling technique

The study was conducted in purposefully selected two districts, Rupandehi and Nawalparasi, due to the significant involvement of the local population in kitchen gardening and vegetable cultivation. Initially, I compiled a list of individuals actively engaged in vegetable farming and kitchen gardening from the Agricultural Knowledge Centers (AKCs) in the Rupandehi and Nawalparasi districts. From this list, we employed a random sampling technique through a lottery method to select a total of 141 farmers for our survey. Among these participants, 76 were from the Rupandehi district, and 65 were from Nawalparasi district.

Research Design

Pre-Survey

Before the actual survey, we conducted a preliminary study involving a total of 5 households. This pre-survey provided valuable insights that aided in the preparation of the questionnaire.

Household survey

The Household Survey was conducted through face-to-face interviews, utilizing a pre-tested semi-structured interview schedule. This survey involved the collection of primary data from a total of 141 farmers in the study area. Out of these, 76 respondents were from Rupandehi district, and 65 were from Nawalparasi district. The interviews were primarily focused on gathering demographic information and acquiring insights into the farmers' knowledge regarding snails, the damage they cause, and the control measures employed.

Key informant interview

Additionally, key informant interviews were conducted with professionals from agricultural organizations such as officers of AKC. The information gleaned from these interviews served as valuable corroboration for the data obtained from the household survey.

Data collection

Primary data was collected from farmers within the study area through various research instruments, including door-to-door interviews using structured questionnaires, focus group discussions, key informant interviews, and direct field observations. Secondary data was also collected from various sources, including:

- **Documents and Publications:** Reference was made to documents and publications from the Ministry of Agriculture and Livestock Development (MoALD), the Nepal Agricultural Research Council (NARC), and other governmental agencies to supplement the research.
- **Journal Articles:** Relevant journal articles from institutions such as the Agriculture and Forestry University (AFU), Tribhuvan University (TU), and international journals provided additional valuable secondary data.
- **Books, Annual Reports, and Research Papers:** Information was gathered from books, annual reports, and research papers to enrich the secondary data collection efforts.

Data Analysis

Survey data was processed in Microsoft Excel, and then used for analysis. Statistical tools including averages, percentages, and means, were applied for comparison. Data presentation was enhanced through the creation of charts and tables.

RESULTS AND DISCUSSION

Abundance of snails and slugs

Snails were reported in almost all surveyed settlements in Rupandehi and Nawalparasi districts. A higher number of respondents mentioned the presence of snails in their area for the last 0-4 years and 4-8 years, with very few reporting snail presences for the last 12-24 years (Table 2). A similar pattern was observed in a survey in Janakpur district (Jha, 2019).

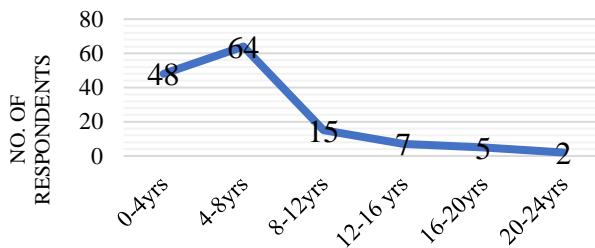


Figure 1. Duration of possible abundance of snails and slugs (N=141)

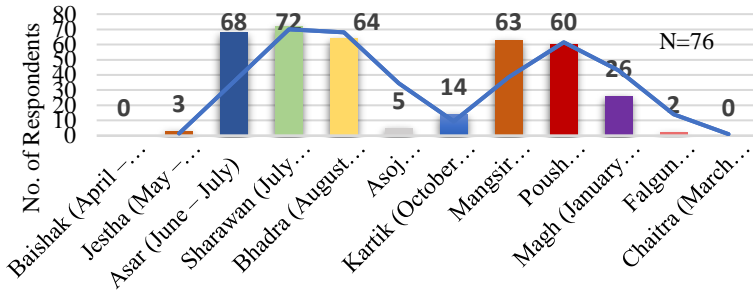


Figure 2. Monthly occurrence of snails and slugs in Rupandehi (September-October) and Kartik (October-November), followed by a resurgence during the cool season, before decreasing once more in the subsequent months

Monthly occurrence of snails and slugs

As depicted in Figure 2, snails and slugs exhibit their highest prevalence during the rainy season, spanning from Asar to Bhadra (June-September) in Rupandehi. Subsequently, their abundance declines during Ashoj. As illustrated in Figure 3, snails and slugs exhibit their highest prevalence during the rainy season, spanning from Asar to Bhadra (June-September) in Nawalparasi. Subsequently, their abundance declines during Ashoj (September-October) and Kartik (October-November), followed by a resurgence during the cool season, before decreasing once more in the remaining months. A similar trend was observed by Jha (2019), Raut & Ghose (1979, 1984), and Raut & KC. (1999), indicating that snails, including the Giant African Land Snail and Horntail Snail, occur seasonally, affecting crops. Moreover, slugs predominantly favor wet and damp seasons (Bhandari, 2021). The study also reveals that slug egg survival decreases with rising temperatures, as observed both in laboratory and outdoor experiments (Hata *et al*, 2017). Similarly, the population of snails and slugs correlates with edaphic factors, with populations decreasing as soil temperature rises and soil moisture decreases (Kaur *et al*, 2017).

Abundance of snails and slugs in different habitats

Snails and slugs were found in various types of habitats, including gardens, fields (referred to as "khet" and "bari"), paddy fields, and near water sources. The highest numbers of snails and slugs in Rupandehi were observed in gardens and fields, while the least were found in paddy fields and near water sources. They were also frequently spotted along roadsides and on house walls (Figure 4). Figure 5 reveals that the highest number of snails and slugs were reported from bari

and water sources, while a moderate number was found in gardens, and very few were observed in paddy fields and near "khet" areas in Nawalparasi district.

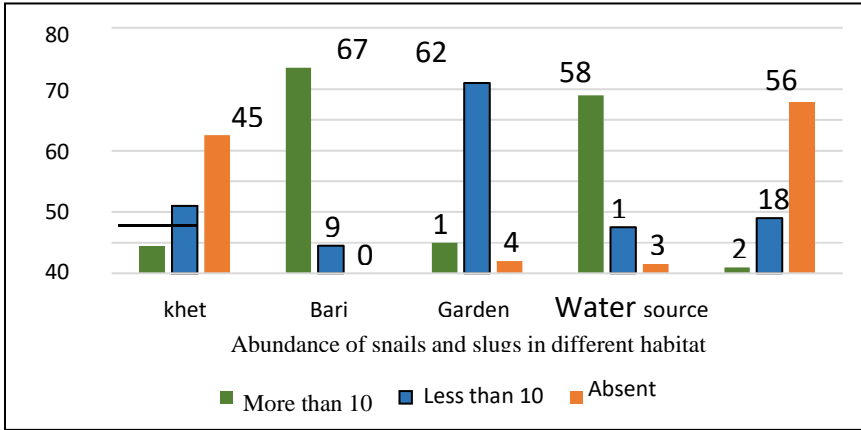


Figure 3. Abundance of snails and slugs in different habitats at Rupandehi

Research conducted by Raut and Baker in 2002 and Jha in 2019 has shown that the highly invasive GALS snail is commonly sighted in locations such as building walls, roadside gardens, "bari" fields, water sources, and other moist areas. These habitats are often observed in old walled buildings and boundary walls, as noted by Budha & Naggs in 2008. However, there have been no studies conducted on the population of slugs in relation to these habitats.

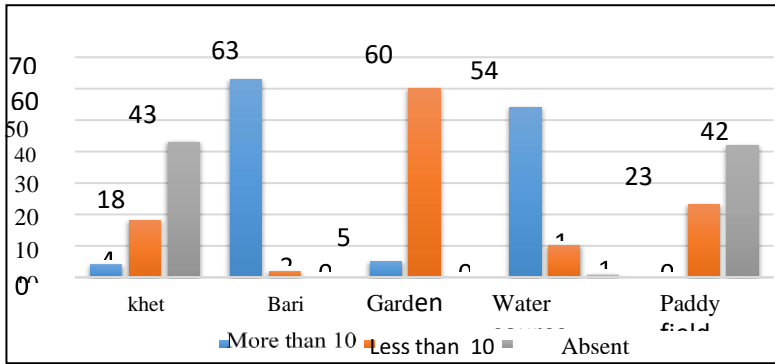


Figure 4. Abundance of snails and slugs in Nawalparasi

Prevalence of snails and slugs

Figure 6 illustrates that in Rupandehi district, the Giant African Land Snail was identified as the most damaging snail to crops, followed by the Horntail Snail, which is considered a moderate threat. Slugs were reported as causing the least harm to crops in both kitchen gardens and vegetable fields, as per the respondents' observations. Based on Figure 7, the majority of responses indicate that the Giant African Land Snail is the most prevalent in Nawalparasi district, followed by the Horntail Snail in a moderate position, while slugs were reported to be the least abundant. In 2013, Budha documented the presence of alien and invasive fauna in Nepal, including GALS, horntail snails, and some slugs. In 2015, Budha listed a total of 64 alien fauna in Nepal. The rapid spread of GALS in Nepal has been well-documented, as noted by Budha and Naggs in 2008 when they created the first distribution map of the species. Since then, this snail has been introduced to almost all Terai districts. The Giant African Land Snail is considered a serious vegetable pest and a major issue in kitchen gardens, as reported by Budha and Naggs in their 2005 article.

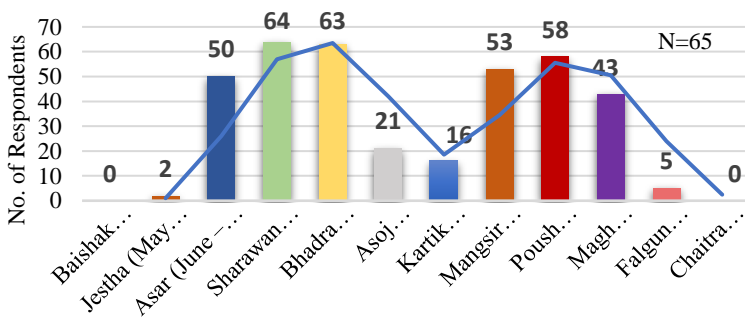


Figure 5. Abundance of snails and slugs in different months at Rupandehi

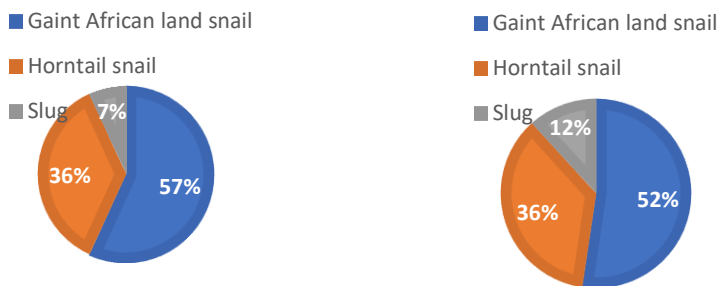


Figure. 6 Prevalence of snails and slugs in Rupandehi Figure.7 Prevalence of snails and slugs in Nawalparasi

Knowledge of most susceptible crops to snails and slugs

From the Rupandehi district, 76% were aware of the most preferred crops of snails and slugs, while 24% were not sure, as they had observed damage to various types of plants without a single clear preference. According to their responses, cucurbits were the most susceptible, followed by Cole crops and other vegetables such as okra and brinjal. Snails and slugs were reported to cause approximately 50% damage to the seedlings of these vegetable crops. Out of the 65 respondents from Nawalparasi, 68% reported that green leafy vegetables, cucurbits, and Cole crops are highly susceptible to snail damage, along with taro, okra, and brinjal to a lesser extent. Meanwhile, 32% of respondents were not aware of the most susceptible crops and mentioned that snails feed on various plants in the field (Figure 8). It's noteworthy that even a small number of 3-4 snails and slugs can devastate vegetables within a 2 sq. ft area. Snails, particularly the GALS, can completely destroy crops such as cauliflower, cabbage, cucumber, sponge gourd, potato, tomato, brinjal, and others (Buddha *et al.*,2005). Vegetable crops are predominantly affected by snails and slugs (Bhandari, 2021).

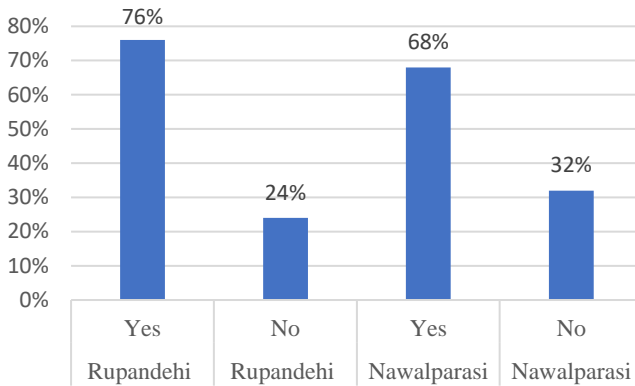


Figure 8. Knowledge of most susceptible crops to snails and slugs local control measure

The locally adopted control measures include collecting and disposing of snails in the river, crushing live individuals, discarding them on roads, placing them in garbage carried by tractors, and applying alcohol and detergent. Among these methods, crushing live individuals was identified as the most effective control technique employed by the residents of Rupandehi (Figure 9). Out of the 65 respondents interviewed, 64 individuals provided their responses regarding

control measures for snails prevalent in their area. Locally adopted control measures include collecting and disposing of snails in the river, crushing live

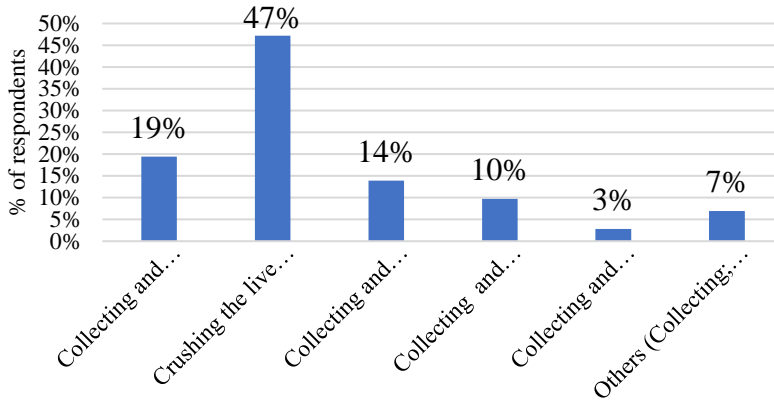


Figure 9. Local control measure for snails and slugs in Rupandehi

individuals, and discarding them on roads. Additionally, some respondents mentioned the use of alcohol and detergent. Among these methods, crushing live individuals was identified as the most effective control technique adopted by the local people of Nawalparasi (Figure 10). In a study conducted by Jha in 2019, it was observed that the local people in Janakpur employed control measures such as crushing the snails, pouring salt over them, removing their hiding places, and searching for eggs. Among these measures, pouring salt was reported as the most effective control method.

Enemies of snails and slugs

Among the mentioned predators, which included the Great egret and Greater coucal, the majority of respondents from Rupandehi reported that the Greater coucal is the predator of Giant African Land Snails (GALS) and slugs (Figure 11). Similarly, respondents from Nawalparasi mentioned several potential predators, including the Great egret, crow, and Greater coucal, with the highest percentage of people reporting that the Great egret is the predator of Giant African Land Snails (GALS) and slugs (Figure 12). Additionally, it's worth noting that GALS are known to be consumed by various animals, such as crows, monitor lizards, Common man goose, and pigs, as documented by Budha and Naggs in 2005. The greater coucal feeds on large varieties of foods which include snails and slugs too

(Kit Lan, 2020). Great exert has been reported to feed on snails and slugs (NYNHP, 2023).

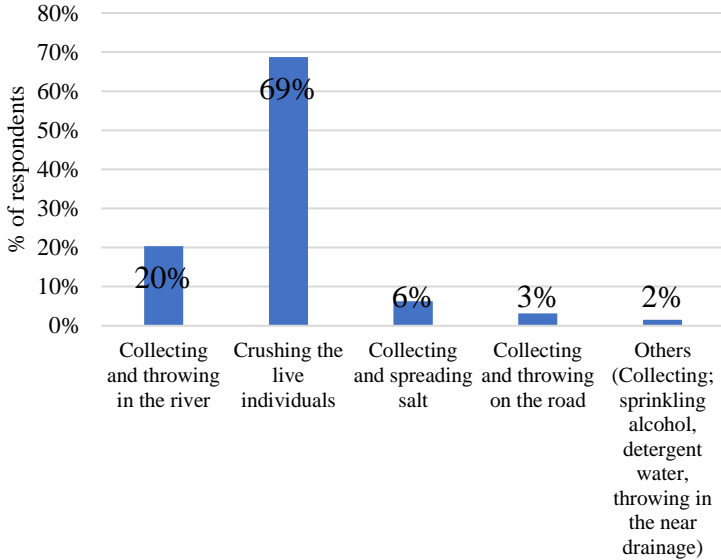


Figure 10. Local control measures for snails and slugs in Nawalparasi.

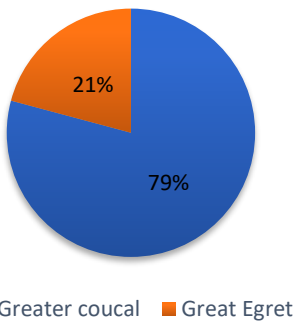


Figure11. Enemies according to locals of Rupandehi

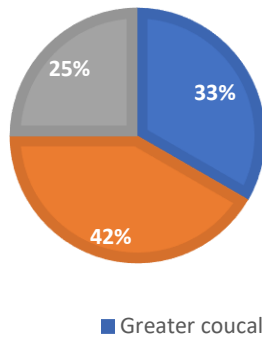


Figure12. Enemies according to locals of Nawalparasi

Use of chemicals to mitigate snail and slug populations

According to the respondents, those who use chemicals from Rupandehi typically employ Metaldehyde GR 6%, which is available in the market under the name "King Foe" and is recommended by Argo vets. Some respondents also mentioned using other pesticides, such as Cypermethrin and Dimethoate 30% EC, to control snails and slugs. Only 20 individuals from Nawalparasi reported using chemicals to manage snails and slugs, including molluscicides recommended by Argo vets. Some respondents mentioned using Cypermethrin and other pesticides for snail and slug control (Figure 18). According to a study by Hata *et al.*, in 1997, growers and farmers commonly used conventional bait pellets containing molluscicides like methiocarb and metaldehyde.

CONCLUSION

Based on the findings of this study, it is evident that the populations of snails and slugs have experienced a substantial increase in both districts over the past 4-8 years. This conclusion is drawn from the insights gathered from 141 respondents, who consistently reported that these troublesome pests inflict the most damage to crops during the monsoon and cool seasons, particularly in the month of Asar (June-July) & Shrawan (July-August). Furthermore, the study shed light on the preferred habitats of these pests, with gardens and farmlands being their primary residence, followed by roadside areas, house walls, and locations near water sources. Respondents from both districts unanimously identified the Giant African Land snail as the most prevalent among these pests, with slugs and horntail snails being less common in their respective localities. The research also revealed that these pests exhibit a penchant for a diverse range of vegetables, including Cole crops, cucurbits, brinjal, okra, and taro, all of which are frequently subjected to their damaging activities. In response to this agricultural challenge, respondents employed various methods for pest management, including collecting and disposing of the pests in garbage-carrying vehicles or nearby rivers, crushing them, applying salt, tossing them onto roads, and using alcohol or detergents. Among these strategies, crushing emerged as the most widely adopted method. Additionally, the study identified the Greater Coucal, Great Egret, and crows as the primary predators of snails and slugs in the study area. It is noteworthy that only a small percentage of respondents from both districts resorted to chemical methods for pest management, indicating a preference for non-chemical approaches among the local populace.

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