U.S. DEPARTMENT OF AGRICULTURE

Rodenticide Usage in Outdoor Agricultural Production

Results From a Survey Conducted by the USDA Office of Pest Management Policy

Claire Paisley-Jones and Michelle Ranville[1] July 2023

This data collection, conducted by USDA's Office of Pest Management Policy (OPMP), was authorized by the Agriculture Improvement Act of 2018 (Title X, Section 10109), and is approved under OMB Control No. 0503-0206.[2] The survey program is designed to gather information from trusted-expert agricultural advisors, consultants, and extension agents. This information can be used to help USDA characterize pest management practices, and ultimately can be used to inform pesticide use regulations and pesticide label language to better balance grower needs and environmental protection goals. The results of this survey indicate that an overwhelming number (>95 percent) of surveyed experts concluded that there will be significant challenges to implementing the Environmental Protection Agency's (EPA) mitigation proposal for rodenticides.

Summary Highlights

- 429 respondents—representing over 6,500 agricultural operations where rodenticides are registered.
- Approximately two-thirds of respondents reported using rodenticides on one or more operations.
- Nearly 90 percent of respondents who reported using chemical rodenticides in outdoor agriculture also reported using at least one other method of rodent control.
    - On average, rodenticide users utilized three methods of rodent control, suggesting that they are using chemical rodenticides as part of an integrated pest management (IPM) strategy.
    - Approximately 75 percent of those who did not use rodenticides reported that they did not utilize any alternative rodent control methods, suggesting that rodents may not have been not problematic for the operations they represent.
- Respondents indicated that the overall percent of operations treated with rodenticides is low, but rodenticides are critical tools when needed.
- Reported rodenticide usage was higher in orchards and other perennial crops than in annual crops.
- Diphacinone and zinc phosphide were the two most commonly reported active ingredients used in outdoor agricultural production areas.
- In free text comments, respondents noted:
    - The key role of chemical rodent control for public health, including food safety and compliance with food safety laws and standards.
    - Rodenticides support climate-smart agriculture goals: they provide control of rodents that harbor in cover crops and vegetative cover strips and reduce the need for tillage or flooding to control severe rodent infestations.
- Over 95 percent of respondents who reported using rodenticides predicted negative impacts from one or more of EPA's proposed mitigations.

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[1] USDA Office of Pest Management Policy. See https://www.usda.gov/oce/pest/about

[2] OMB Control Number: 0503-0026; Generic Clearance of Multiple Crop and Pesticide Use

Introduction

In November 2022, the Environmental Protection Agency (EPA) published Proposed Interim Decisions (PIDs) for 11 chemical rodenticides.[3] Four of these rodenticides (chlorophacinone, diphacinone, strychnine, and zinc phosphide) are currently approved by EPA for outdoor "field-use" in agriculture. Currently available pesticide usage data sources do not provide robust information on rodenticide usage, which makes it difficult to understand where, when, and how these rodenticides are actually being applied, including: common application methods, application rates, and pests being targeted (collectively referred to as "usage"). USDA conducted this survey to enhance our understanding of chemical rodenticide usage in outdoor agricultural production areas, to determine how nontarget exposure to rodenticides is managed, and to identify how EPA's proposed mitigations to field-uses of rodenticides could impact growers. Respondents mentioned the key role of effective rodent control for public health, food safety, and climate smart agricultural practices, though this survey was not specifically designed to address those topics. The data collected through this survey is intended to inform interagency and stakeholder discussions on the usage and importance of these rodenticides through feedback from agricultural experts. While not designed to provide statistically significant estimates of chemical rodenticide usage, the results of this survey provide substantive information from trusted agricultural experts who represent a wide population of agricultural operations.

The survey was distributed through Qualtrics™ in January 2023 to independent crop consultants (ICCs) affiliated with the National Alliance of Independent Crop Consultants (NAICC), certified crop advisors (CCAs) affiliated with the American Society of Agronomy (ASA), and county extension agents affiliated with the National Association of County Agricultural Agents (NACAA). Agricultural producers routinely rely upon experts from these groups for research and guidance on effective/appropriate agronomic practices, including use of pesticides. As such, surveying this select group of individuals can provide information on the practices employed by a broad range of agricultural producers. The survey was open for a 2-week period. Respondents were asked to report on rodent control practices utilized over the past 5-year period on operations with which they were involved (either in an advisory/consultant capacity or as a grower). The majority of survey questions were multiple choice and focused on "use sites" (i.e., locations/agricultural systems/crops), pests, and methods that are specifically approved for agricultural field-use of products containing four rodenticide active ingredients (AIs) currently undergoing registration review at the Environmental Protection Agency (EPA). Opportunities were provided within the survey for respondents to elaborate on their answers or specify options not explicitly included in the multiple-choice options in free-text response fields.

The survey was designed using question "routing" and "piping" techniques to ensure that respondents only received questions relevant to their reported practices. For example, respondents only received questions about chemicals and practices that they reported using, on crops with which they reported being associated. These techniques in addition to some survey attrition resulted in different numbers of observations/answers for different questions. The number of observations for each question (n) is listed in the figure captions. The majority of results are reported as a percent of total respondents. Because respondents could provide more than one answer to some questions, percentages may not total to 100.

[3] Pesticide Registration Review; Proposed Interim Decisions for the Rodenticides; Notice of Availability. 87 Fed. Reg. 73297 (November 29, 2022)

Respondent Details

Respondents were asked to report the rodent control methods used in the past 5 years on outdoor agricultural use site where rodenticides are registered. Of those who received a link to the survey, 429 provided a complete or partial response. Respondents represented certified crop advisors (77 percent of respondents), faculty/staff of academic institutions (e.g., professors, researchers, extension agents) (18 percent), and independent crop consultants (5 percent). The majority of respondents (75 percent) reported themselves as agricultural producers in addition to their reported roles as advisors, educators, and consultants. The survey received responses representing 46 states, with the majority reporting from the Midwest and West production regions (Figure 1). Most respondents (91 percent) had 10 or more years of experience in one or more of the crops for which they provided responses. As this survey targeted crop advisors, consultants, and extension agents, each individual respondent could potentially provide information for rodent control practices on multiple operations. Over half of respondents (59 percent) reported representing more than 20 agricultural operations (i.e., they provided professional guidance to >20 individual agricultural operations). As such, this survey's responses represent rodent control practices on over 6,500 agricultural operations. While the majority of respondents represented more than one agricultural operation, in the summary statistics presented below, each respondent's answers were weighted equally (i.e., results were not scaled based on number of operations represented). The information on number of operations represented by respondents is included only to contextualize the representativeness of the survey's results. Nearly two-thirds of respondents (287, 65 percent) reported using chemical rodenticides in one or more of the crops on which they advised or managed (this group is referred to as "rodenticide users") (Figure 1).

Respondent details:

- Total respondents: 429 (representing over 6,500 operations).
- Represented independent crop consultants, certified crop advisors, and county extension agents.
- 91% of respondents had 10+ years of experience in agricultural production.

The survey focused on the major registered outdoor agricultural use sites for rodenticides (pasture/rangeland, alfalfa/forage/hay, tree fruit and nut orchards, vineyards, vegetables, grains, and fallow agricultural land). The "other crops" category includes respondents who reported rodent control activities on other registered use sites including various grass and forage crops grown for seed, ornamental nurseries, forest tree orchards, hops, oilseed crops, and sugarcane. Table 1 shows the number of respondents who were involved with each use site as well as demographic information about their experience and reach.

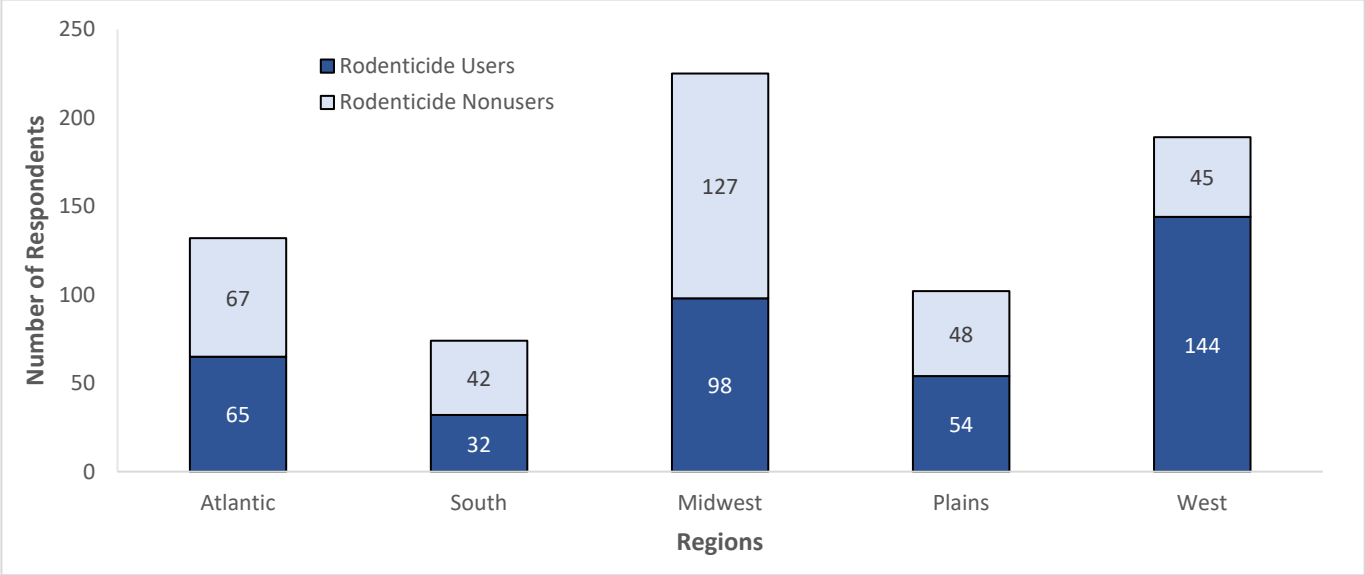

Figure 1. Number of survey respondents displayed by NASS Production Region[4] with breakout of those who reported using chemical rodenticides (rodenticide users) and who did not use chemical rodenticides (rodenticide nonusers). Note that respondents could select multiple States (n=429). **Survey questions:** *In which U.S. State(s) and/or territories were you involved with the production of the crops indicated above in the past 5 years? Select all that apply.; In the past 5 years, which methods were used to control rodents in the operations you are involved with? Select all that apply.*

Table 1. Respondent demographics by use site (n=429)

Use Site	Number of Respondents	>10 Years Experience	Involved with >10 Operations	Used Rodenticides
Pasture/Rangeland	256	88%	49%	38%
Alfalfa/Forage/Hay	291	87%	50%	43%
Vegetables	135	80%	36%	39%
Grains	334	88%	66%	44%
Vineyards	53	75%	30%	51%
Tree Nut Orchards	63	75%	52%	71%
Tree Fruit Orchards	63	75%	28%	64%
Citrus Groves	86	67%	37%	53%
Fallow Agricultural Land	129	85%	44%	40%
Other Crops	51	63%	49%	39%

Survey questions*: In the past 5 years, which of the following outdoor agricultural production systems were you involved in (either as a producer or in an advisory capacity)? Select all that apply. For approximately how many years have you been involved in production of the crops indicated above? Approximately how many operations of the crop systems identified do your answers represent?*

[4] This grouping uses the Agricultural Resource Management Survey (ARMS) III Production Regions. **Midwest region**: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. **Plains region**: Kansas, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas. **Atlantic region**: Connecticut, Delaware, District of Columbia, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Tennessee, Vermont, Virginia, and West Virginia. **South region**: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, and South Carolina. **West region**: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. ARMS III Production Regions map available at https://www.nass.usda.gov.

Rodent Control Methods

Respondents reported that chemical rodenticides were used on all agricultural production sites included in the survey. Chemical rodenticide application was the most commonly reported rodent control method used by respondents and/or one or more of the operations they represent across use sites (64 percent of all respondents) and for each individual use site (Figure 2). Trapping (49 percent) and biological control (34 percent) were also commonly reported across use sites. Sanitation (29 percent) and exclusion (17 percent) were less commonly reported. The low percent of respondents reporting use of sanitation and exclusion is to be expected for field uses. While these methods can be effective for buildings and other indoor use sites, they are often impractical or impossible to implement in outdoor agricultural settings.

Respondents could also enter other control methods in addition to those specifically listed in the survey. Other free-text responses included: rodent habitat destruction (flood irrigation, tillage, vegetation removal), mechanical extermination (shooting, explosives, propane/oxygen ignition devices), and other chemical control methods (smoke, carbon dioxide, carbon monoxide, chemical repellants/irritants). While several respondents reported use of flood irrigation, one respondent noted that *"flood irrigation works well [for rodent control], however, most operations have moved to drip [irrigation] or sprinklers."* Additionally, flood irrigation is increasingly difficult to implement in areas with water shortages and is only effective against rodents burrowing in the field (not on field edges). Responses for rodent control methods by use site are provided below, note respondents could select more than one option (Figure 2).

Of those respondents who reported using rodenticides ("rodenticide users"), 245 (89 percent of rodenticide users) also reported using at least one other method of rodent control, either in the same crop or another crop with which they were involved. On average, rodenticide users utilized three methods of rodent control, including chemical rodenticides; the most common nonrodenticide methods employed by rodenticide users were trapping (58 percent of rodenticide users), biological control (42 percent), sanitation (38 percent), and exclusion (21 percent). This suggests that rodenticide users are knowledgeable about other methods of rodent control and are using chemical rodenticides as part of an overall integrated pest management (IPM) rodent control strategy, rather than relying on rodenticides as a sole solution. Conversely, the majority (75 percent) of respondents who indicated that they did not utilize chemical rodenticides on any crop (referred to as "rodenticide nonusers") reported that they did not utilize any rodent control methods, suggesting that rodents may not have been problematic for the operations they represented.

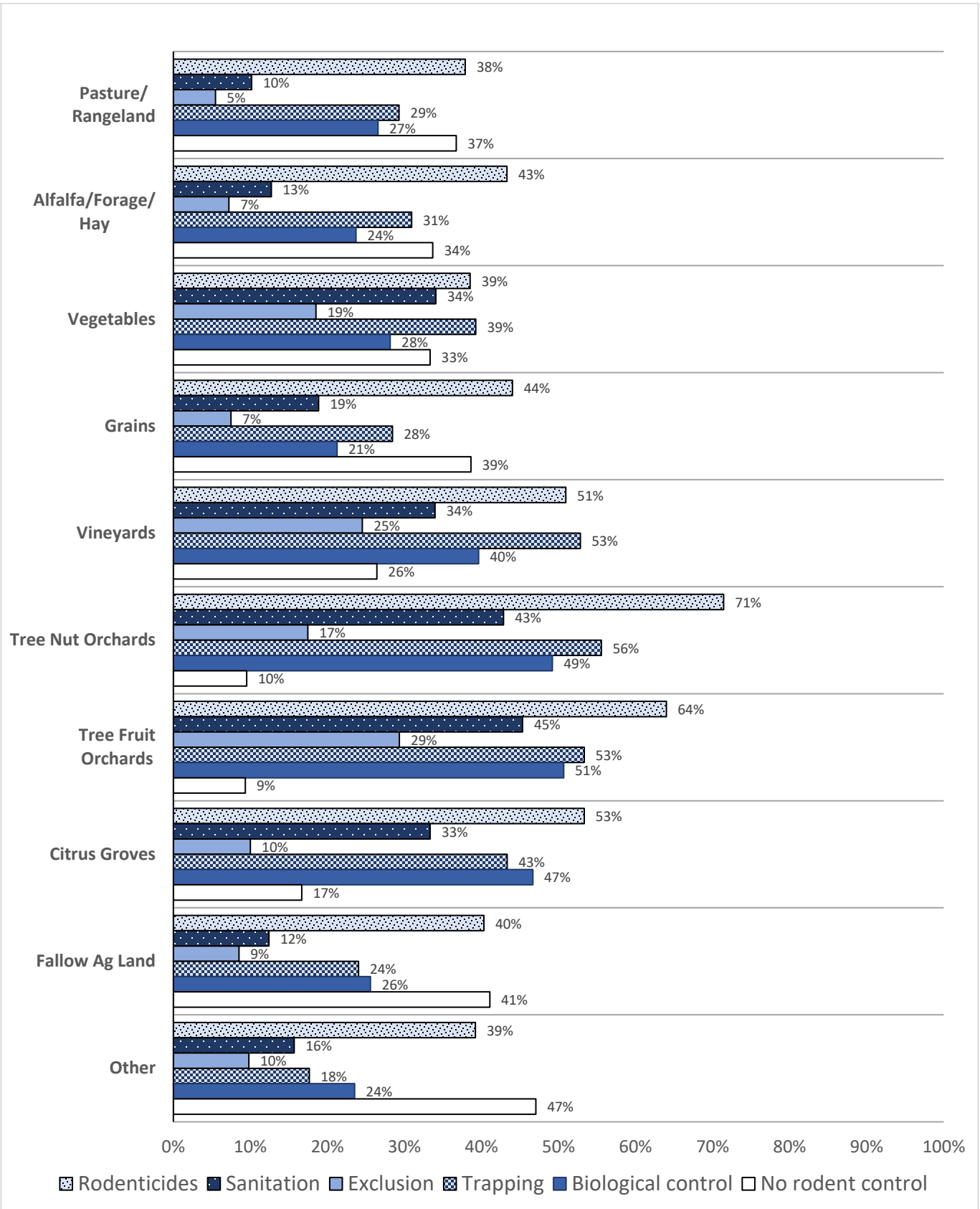

Figure 2. Percent of respondents who reported using rodent control methods in the past 5 years, reported by agricultural use site (n=427). **Survey question:** *In the past 5 years, which methods were used to control rodents in the operations you are involved with? Select all that apply*.

Of note is the higher percentage of perennial crop respondents (i.e., vineyards, orchards, groves, which are not harvested annually) who reported using rodent control methods. Chemical rodenticides were reported at a particularly high rate for this group. Over 60 percent of respondent for perennial crops reported using chemical rodenticides, compared to 41 percent of respondents for all other use sites combined (pasture/rangeland, alfalfa/forage/hay, fallowland, vegetables, grains, and other crops) (Figure 3). A similar disparity is noted between these groups in the percent of respondents who reported using no rodent control at all. Among perennial crop respondents, only 14 percent reported using no chemical control, whereas 37 percent of respondents for all other use sites reported using no rodent control at all. The disparity between reported rodent control methods for these use sites points to the disproportionately high rodent pressure faced by perennial crop growers. This pattern of increased pest pressure and chemical rodenticide usage in perennial crops is seen repeatedly in the responses to this survey.

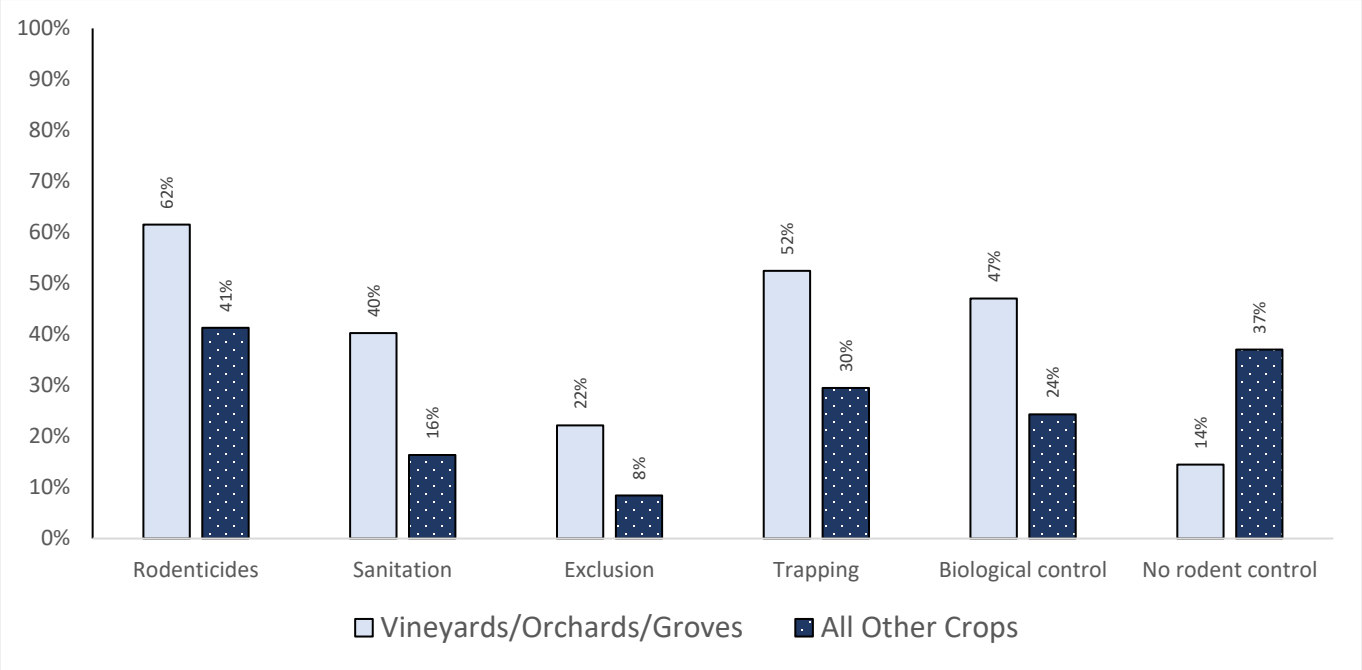

Figure 3. Percent of respondents who reported using rodent control methods in the past 5 years, reported by grouped use site. The Vineyards/Orchards /Groves category includes vineyards, tree nut orchards, tree fruit orchards, citrus groves, and hops, which are not harvested annually. The "All Other Crops" category includes pasture/rangeland, alfalfa/forage/hay, vegetables, grains, fallow agricultural land, and other crops (n=427). **Survey question:** *In the past 5 years, which methods were used to control rodents in the operations you are involved with? Select all that apply*.

Respondents reported a variety of different active ingredients (AIs) are used to control rodents in outdoor agricultural settings. Zinc phosphide was the most frequently reported AI utilized across all surveyed use sites (58 percent of rodenticide users), followed by diphacinone (49 percent of rodenticide users), chlorophacinone (32 percent of rodenticide users), and strychnine (27 percent of rodenticide users). This breakdown may be affected by the number of use patterns registered for each AI. Zinc phosphide is registered for use on many more use sites and pests with many more application methods than strychnine, which is registered only for underground use on a much more limited set of use sites and pests. As was seen with reported usage of rodenticides in general (Figure 3), survey respondents indicated that usage of specific AIs is also higher among perennial crop growers. The percent of respondents reporting usage

of diphacinone and/or zinc phosphide was particularly high in these crops. In addition to the four rodenticide AIs undergoing registration review, 11 percent of respondents reported using other chemical control methods, which are not affected by the current EPA Proposed Interim Decisions. These included: aluminum phosphide (phostoxin), carbon dioxide gas (delivered from compressed gas canister, registered as a pesticide by EPA), and carbon monoxide (produced by a sodium nitrate and charcoal through ignitable gas cartridges, which are registered by EPA as active ingredients, or by a purpose made gas delivery generating machine designated as a pest control device by EPA). All three of these alternative chemical measures (aluminum phosphide, carbon dioxide, and carbon monoxide) are delivered as gases and are therefore only effective for in-burrow applications where all burrow exits can be effectively sealed. The percent of all survey respondents that reported using each AI at least once in the past 5 years by use site are shown by use site in Figure 4 below.

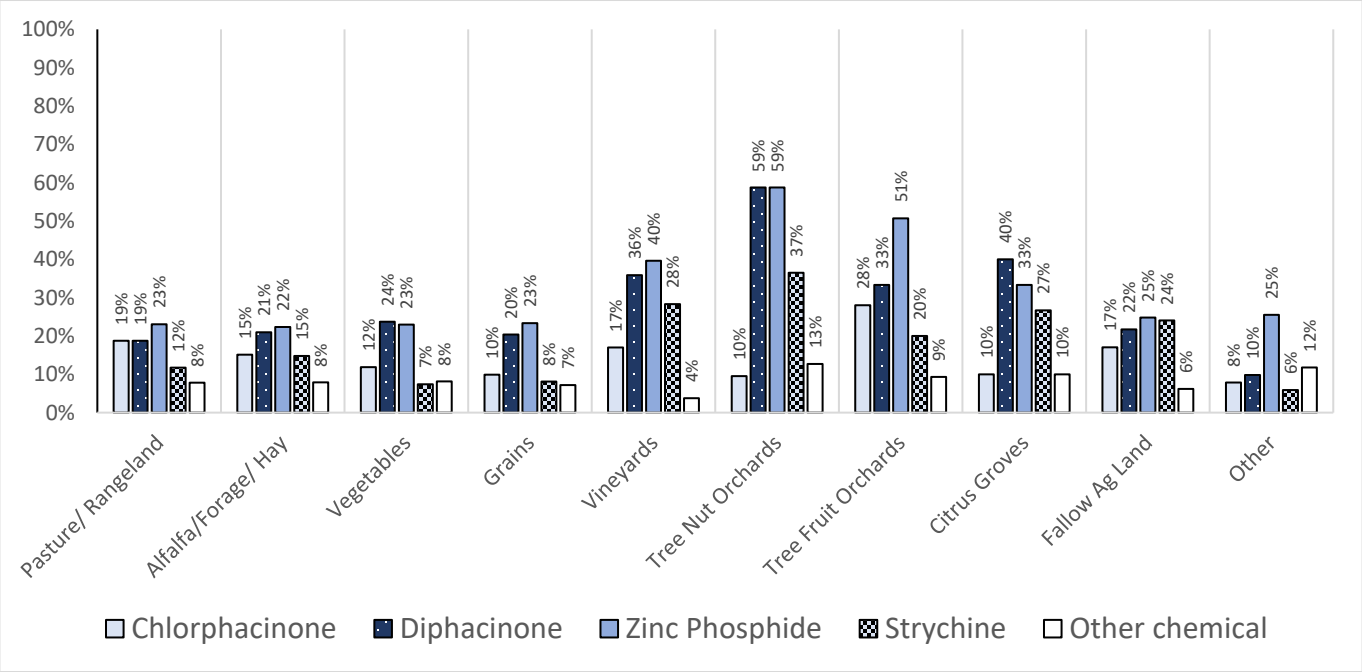

Figure 4. Percent of respondents reporting use of specific chemical AIs by use site over the past 5 years (n=427). **Survey question:** *In the past 5 years, which rodenticide active ingredients were used on the operations you were involved with? Select all that apply.*

Respondents who reported using one of the four active ingredients with approved field-uses currently undergoing registration review by EPA were also asked what percent of the operations with which they were involved were treated with that AI. OPMP averaged these estimates across all responses, counting users who reported not using the particular AI (or not using any AIs) as zeros, to estimate the total percent of operations treated with each AI. Responses by use site are reported below (Figure 5). The results of this calculation show similar patterns to the estimates of percent of respondents who reported using each AI, but are slightly lower, which may indicate that respondents are not treating or recommending treatment using chemical rodenticides on all operations with which they are involved. For instance, about 60 percent of survey respondents reported using diphacinone on tree nut orchards at least once in the past 5 years, but the same survey respondents indicated that only about 30 percent of tree nut orchard operations with which they were involved were treated with diphacinone at least once in the past 5 years.

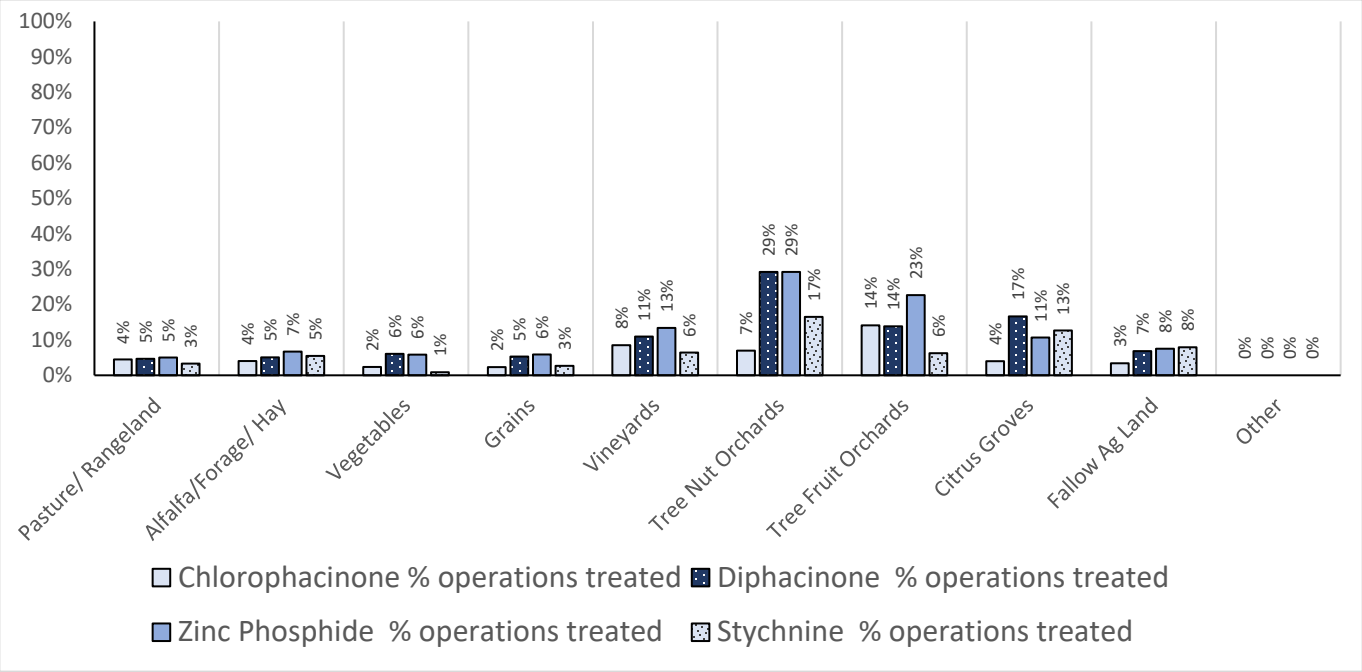

Figure 5. Average reported percent of operations treated with specific chemical active ingredients by use site over the past 5 years, as estimated by respondents for each use site (n=427). **Survey question:** *In the past 5 years, approximately what percent of crop production operations you were involved with were treated with chlorophacinone/diphacinone/zinc phosphide/strychnine?*

Comments provided in optional feedback supported the idea that rodenticide usage is not widespread across all operations or acreage but are a critical tool for rodent control in certain situations. One respondent stated that use of rodenticides was low but *"important when needed."* Another respondent explained the magnitude of rodenticide use as follows:

> *"Rodenticide use in our area consists of spot treatments that target rodents where they are causing significant crop damage. Use is not widespread and affects a very small percentage of total cropland acreage."*

When and Where Rodenticides Were Applied

USDA asked respondents who reported using one of the four chemical rodenticides undergoing registration review what percent of rodenticide applications were made during the *growth period* versus the *nongrowth period* and *in-field* versus *at the field edge*, as both growth period and in-field applications would be limited by EPA's current mitigation proposal. Rodenticide users reported that an average of 39 percent of rodenticide applications were made during the growth period for all crops, with slightly higher percentages of growth periods applications reported for perennial crops—vineyards, tree nut orchards, tree fruit orchards, and citrus groves. This higher reliance on growth period applications for perennial crops (52 percent of applications in the growth period) than other crops (35 percent of applications in the growth period), indicates that the availability of rodenticide treatments that can be applied during the growth period may be particularly valuable for rodent management in the production of perennial crops. The percent of rodenticide applications applied in the growth period by use site is shown below (Figure 6).

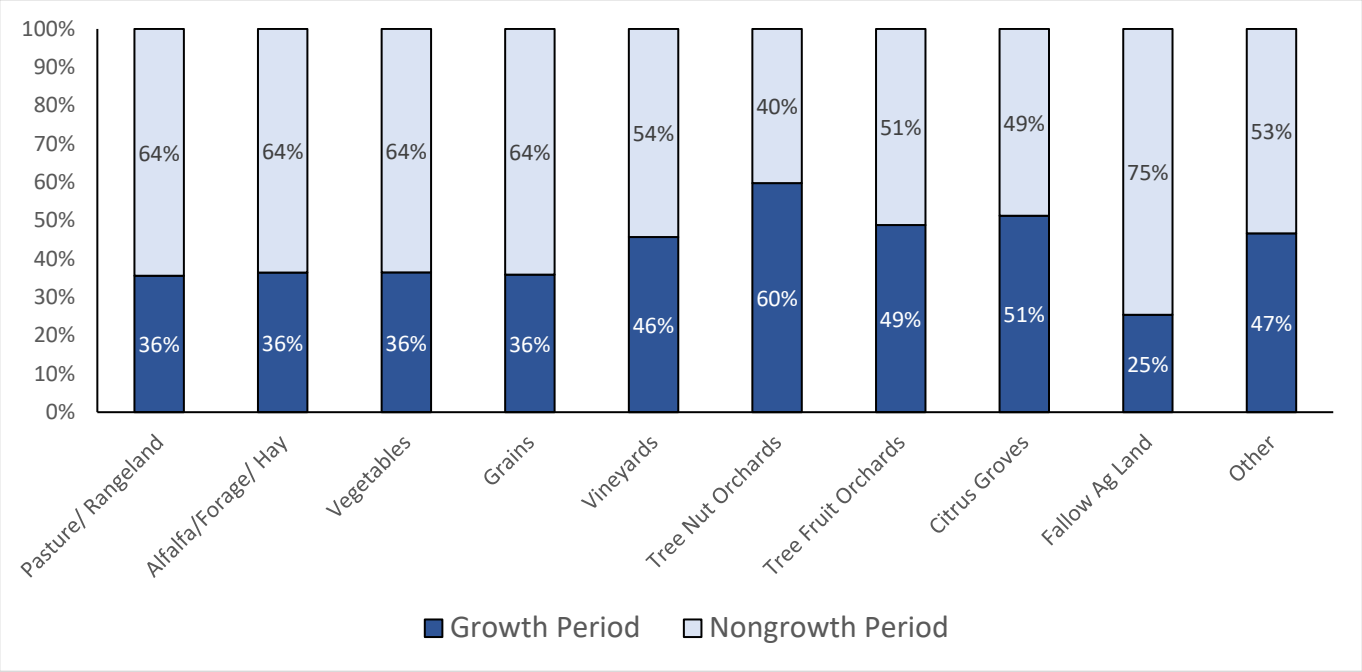

Figure 6. Average reported percent of rodenticide applications during the growth period vs nongrowth period in the past 5 years by use site (n=214). **Survey Question:** In the past 5 years, approximately what percent of rodenticide treatments were applied during the crop growth period versus the nongrowth period? (If all applications were in the growth period, select 100%.) Note: Growth period = Producing crop for harvest or grazing (i.e., bearing). Nongrowth period = Not harvested or grazed for food feed (i.e., dormant season, or 365-day preharvest/pregrazing interval (nonbearing, fallow)).

Comments provided in optional free-text feedback supported the idea that year-round use of rodenticides is necessary to control rodent populations. Multiple respondents mentioned the potential for "rodent population eruptions" without adequate year-round chemical control options. Another respondent commented:

> *"The damage caused by rodents can quickly build in one breeding cycle. The crop and terrain will take much more money to repair and maintain if the use of pesticides is reduced or eliminated."*

Another respondent elaborated:

> *"If it is too hard to control [rodents] because of regulations, they [rodent populations] will increase faster as less people will try to control them, resulting in more use of poisons in the future when [growers] have to do something about them. Both ground squirrels and prairie dogs are exploding here locally, showing up in lots of locations where they haven't been for 40 years or more."*

Respondents who reported using chemical rodenticides reported similar breakdowns for in-field versus field-edge rodenticide applications. Rodenticide users reported that in-field applications made up an average of approximately half (45 percent) of rodenticide applications across all use sites. In-field applications were reported at a higher rate (52 percent of applications) in certain perennial crops (tree nut orchards, tree fruit orchards), wide area use sites (pasture/rangeland), and particularly rodent attractive use sites (alfalfa/forage/hay). In-field applications were reported at lower rates in other crops (vegetables, grains, and citrus groves) (Figure 7).

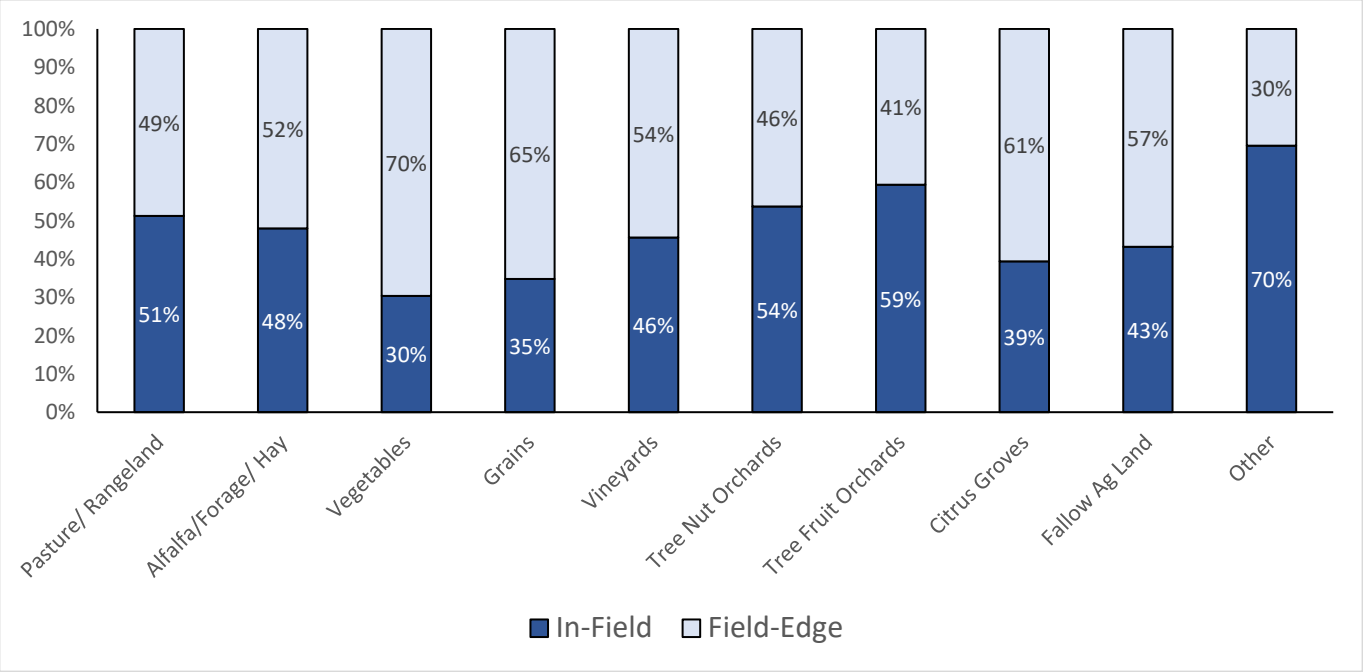

Figure 7. Average reported percent of rodenticide applications in-field vs. at field edge over the past 5 years by use site (n=210). **Survey Question:** *In the past 5 years, approximately what percent of rodenticide treatments were applied in-field versus at the field edge? (If all applications were in-field, select 100%). Note: In-field = in the growing area of the agricultural field. Field edge = at the field edge, not within the growing area itself.*

Comments provided in optional free-text feedback supported the idea that rodenticide use is necessary both in areas adjacent to fields and in the field itself. One respondent explained,

> *"Leaving adjacent areas untreated will just result in a wasted effort as they will move back into the treated area."*

Application Methods and Target Pests

USDA asked respondents who reported using chemical rodenticides the methods employed to apply these AIs. Bait stations were by far the most commonly reported application method for rodenticides across all use sites (65 percent of rodenticide users reported using bait stations in one or more of the use sites with which they were involved). Burrow baiting was also commonly reported across use sites (49 percent of rodenticide users). Ground applied loose bait applications (scatter/spot applications and ground broadcast treatments) were less common, but still reported by many respondents (38 percent and 34 percent of rodenticide users, respectively). These loose bait application methods were more commonly used in pasture/rangeland, alfalfa/forage/hay, and grains, but they were still not uncommon in vegetables, orchards, vineyards, and fallow agricultural land (Figure 8).

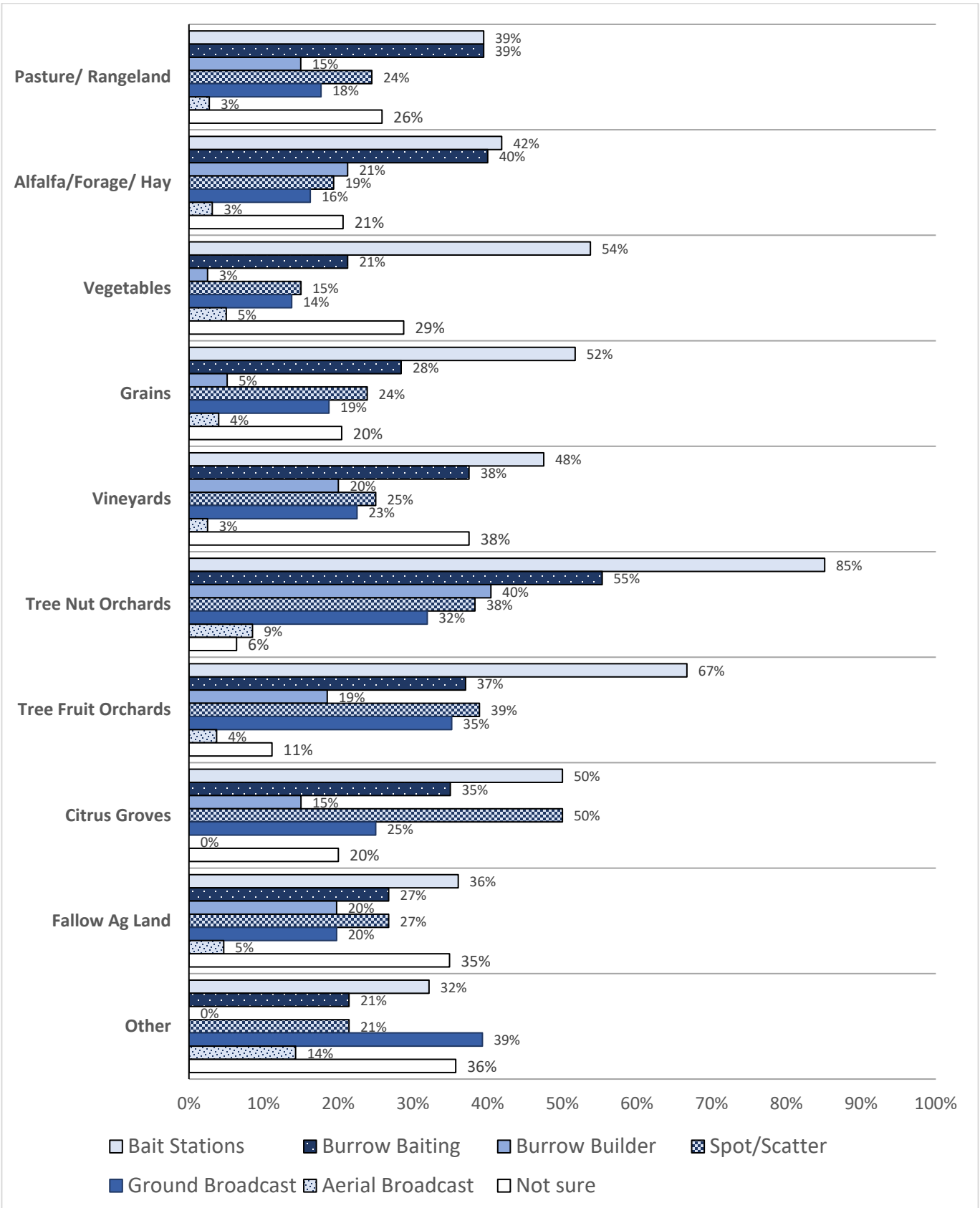

Figure 8. Percent of rodenticide users reporting usage of application methods by use site over the past 5 years (n=244). **Survey Question:** *In the past 5 years, what application type(s) were used when making rodenticide applications in the agricultural production acres you were involved with? Select all that apply*.

Figure 9 displays the number and percent of times that respondents who were rodenticide users reported using "loose" application methods (ground broadcast, spot/scatter, and aerial broadcast) across all use sites, either alone or in addition to other rodenticide application methods, such as bait stations or burrow baiting. As respondents often provided answers based on their involvement with more than one operation, these figures represent respondents who are employing more than one application method across operations, not necessarily operations that are employing more than one method of rodenticide application. It is likely, however, based on the frequency with which respondents reported using these "loose" application methods in addition to other methods of application that in many cases operations are in fact employing multiple methods of rodenticide application. Either way, the data here shows that those consulting/advising on field rodenticide applications utilize/recommend multiple application methods, which suggests that multiple methods of rodenticide application are often needed to control rodent populations.

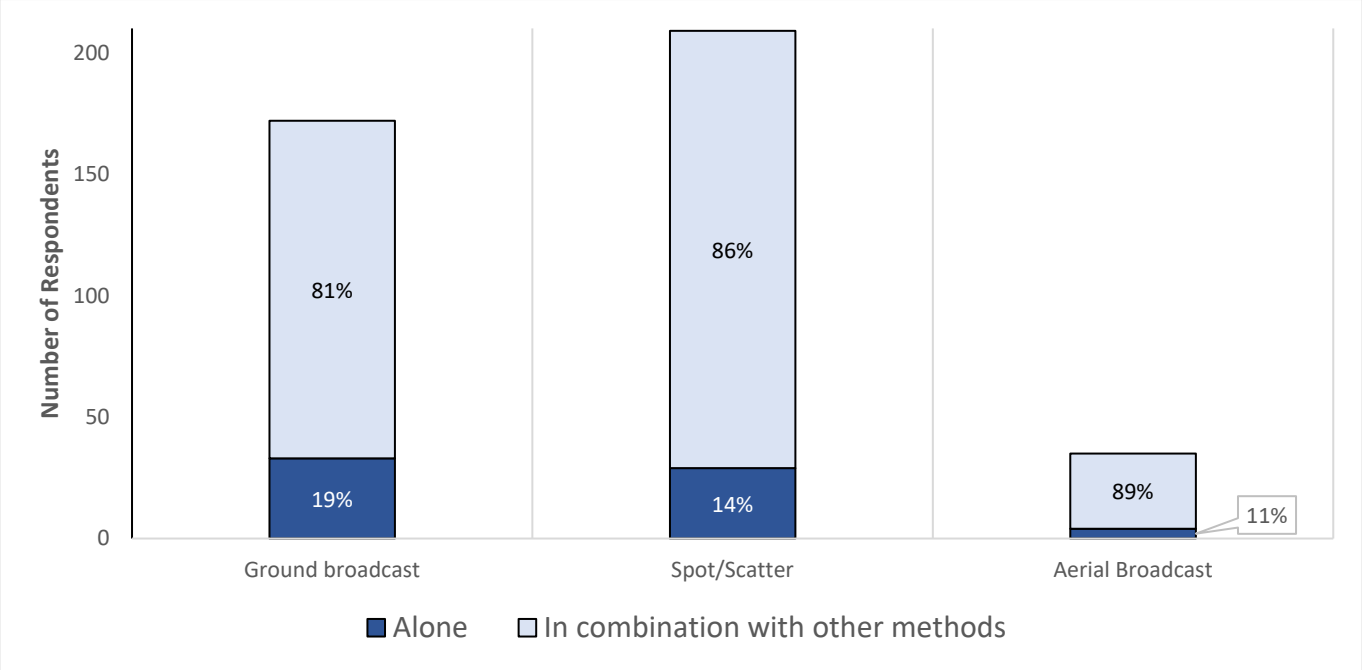

Figure 9. Percent of rodenticide users reporting use of select application types made over the past 5 years alone or in addition to other application types: Ground broadcast, Spot/scatter, and Aerial broadcast (n=244). **Survey Question:** *In the past 5 years, what application type(s) were used when making rodenticide applications in the agricultural production acres you were involved with? Select all that apply.*

USDA also asked respondents who reported using rodenticides what pests they were targeting with chemical rodenticide treatment. Across use sites, mice were the most commonly reported target pest (53 percent of all rodenticide users), followed by voles (52 percent) and pocket gophers (48 percent). Woodrats (2 percent), kangaroo rats (4 percent), and prairie dogs (12 percent) were reported much less frequently across use sites. When looking at individual use sites, however, the prevalence of target pests varied widely (Figure 10). While ground squirrels were reported as a target pest by only 35 percent of respondents across use sites, ground squirrels were reported as the most common rodent pest in tree nut orchards (83 percent of tree nut orchard rodenticide users) and citrus groves (60 percent). Target pests reported for each use site are provided below (Figure 10).

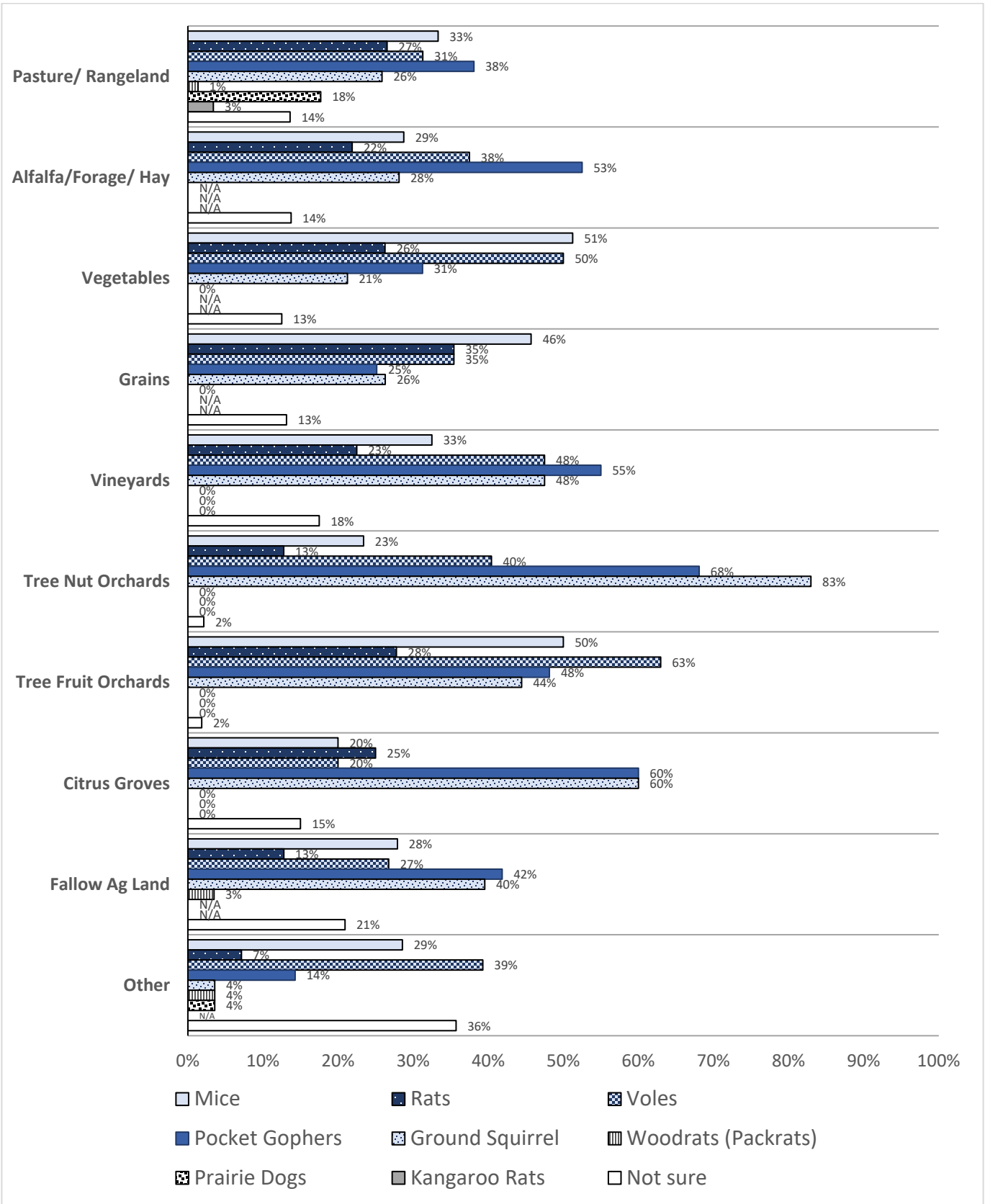

Figure 10. Percent of rodenticide users reporting treatment of target rodent pests, over the past 5 years by use site (n=243).
Survey Question: *What were the target rodent(s) of the rodenticides listed above? Select all that apply.*

USDA asked respondents about factors specific to individual target pests that they reported treating for that limited the use of specific active ingredients or application methods of rodent control. Survey respondents reported a number of pest-specific limiting factors including AI resistance, bait shyness,[5] and bait kickout.[6] The majority of respondents who reported treating for each target pest indicated no pest specific issues, with the exception of 51 percent of respondents who treated for ground squirrels that indicated issues with bait shyness, (Figure 11).

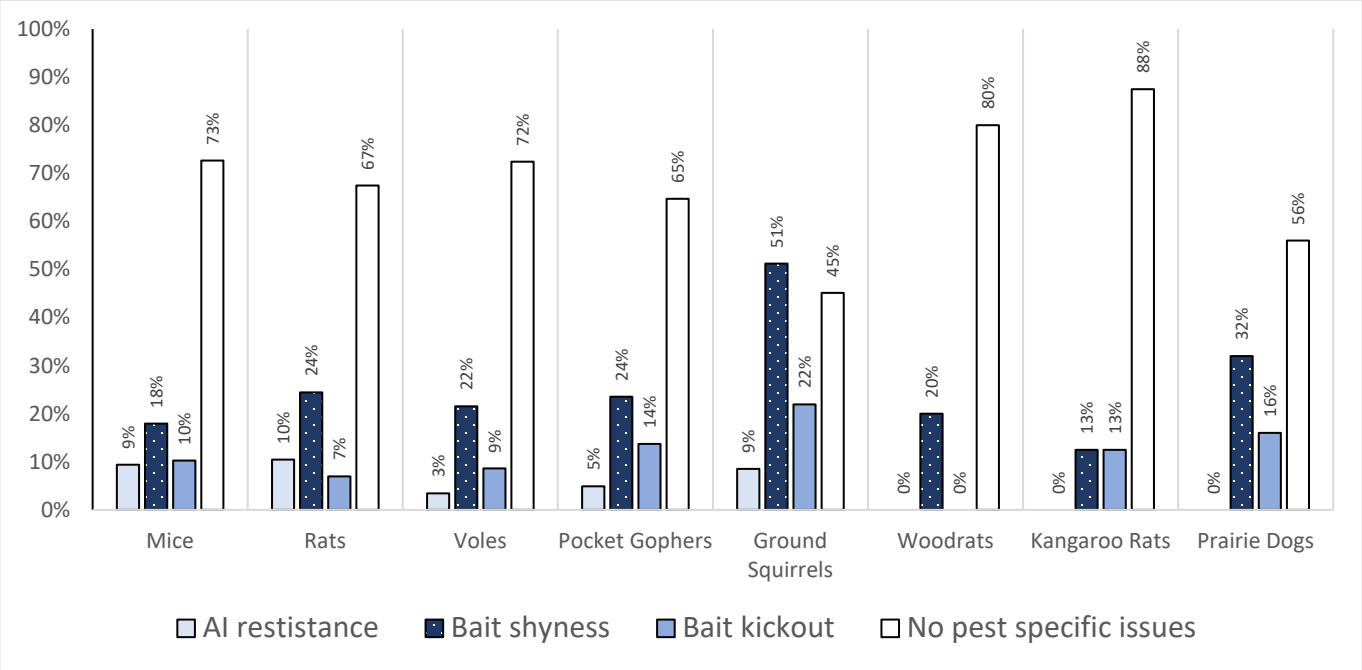

Figure 11. Percent of rodenticide users who reported treating for target pests that reported pest specific issues that limited their use of rodenticides over the past 5 years (n=217). **Survey Question:** *Were there any factors specific/unique to target rodents that limited the use of an active ingredients or application methods? Select all that apply*.

Similarly, rodenticide users reported a number of factors specific to individual AIs that limited their use of the AI. These include: AI resistance, bait shyness, bait kickout, limits on application methods or timing, and weather. Again, most users reported no AI specific issues or limitations. Rodenticide users, however, reported greater issues with weather for zinc phosphide use than with other AIs (30 percent of zinc phosphide users and 15 percent of other AI users respectively). Application method limits were the next most commonly reported AI specific limiting factor (approximately 20 percent across AIs). AI specific limiting factors are displayed in Figure 12.

[5] Bait shyness—learned avoidance of baits due to association with adverse effects from previous sublethal exposure, and/or avoidance of bait due to fear of unfamiliar elements in the environment (such as novel bait stations or bait).
[6] Bait kickout—removal (kickout) of bait from the burrow by rodents.

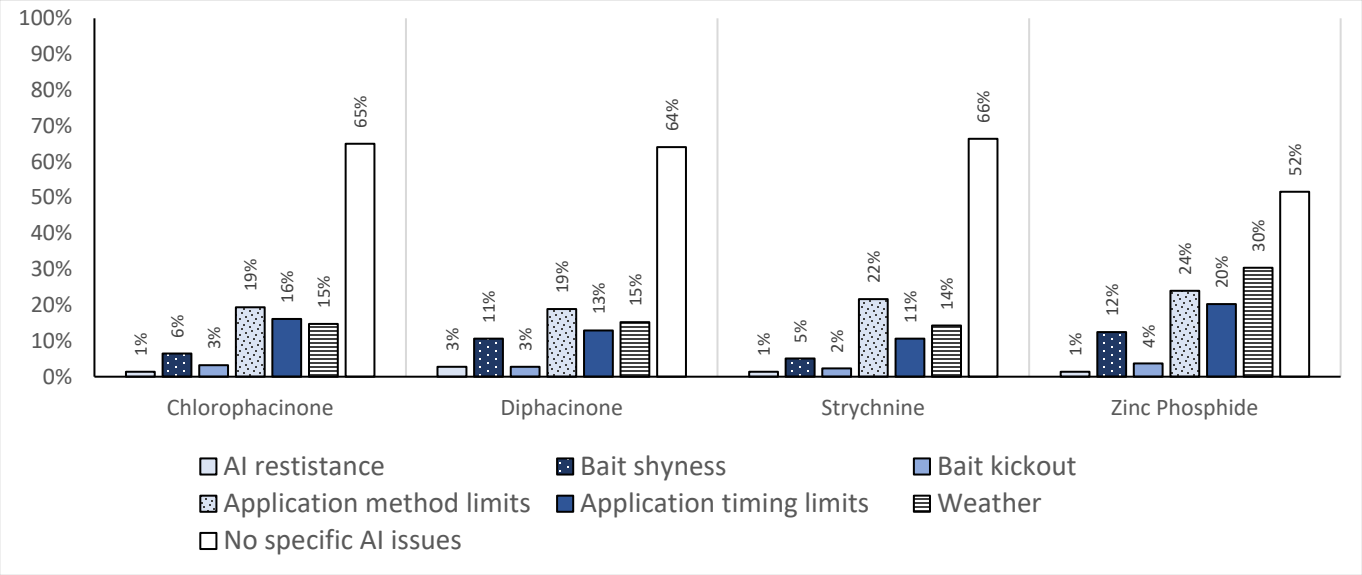

Figure 12. Percent of rodenticide users who reported issues specific to active ingredients that limited their use of rodenticides over the past 5 years (n=217). **Survey Question:** *Were there any factors specific/unique to rodenticide active ingredients that limited their use? Select all that apply.*

Methods Used to Manage Nontarget Exposure

Rodenticide users were asked how they manage exposure of nontarget organisms to rodenticides. The most common method reported across use sites was scouting for rodents prior to application to ensure rodenticides are only applied when target pests are present (81 percent of rodenticide users). Rodenticide users also commonly reported altering application timing (72 percent), using nonrodenticide control methods (56 percent), and use of tamper-proof bait stations (48 percent) to avoid nontarget exposure. Carcass search and disposal was the least commonly reported method to manage nontarget exposure (28 percent of rodenticide users who responded to this question). Methods to manage nontarget exposure aggregated across use site are shown in Figure 13 and methods to manage nontarget exposure by use site are shown in Figure 14.

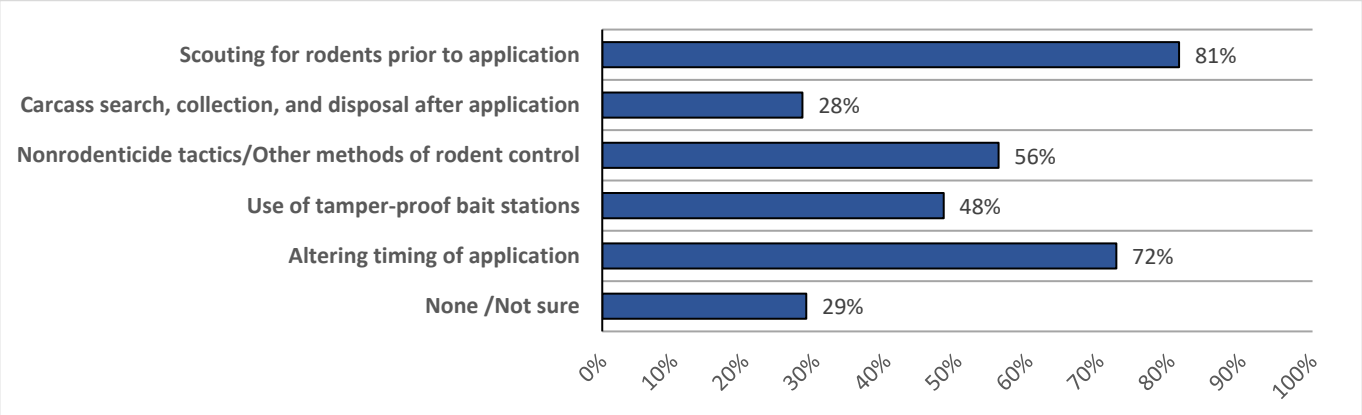

Figure 13. Percent of rodenticide users who reported using practices to manage nontarget exposure to rodenticides over the past 5 years aggregated across use sites. Note: Survey question was limited to rodenticide users (n=181). **Survey Question:** *In the past 5 years, were any of the following practices used to manage exposure of nontarget organisms to rodenticides? Select all that apply.*

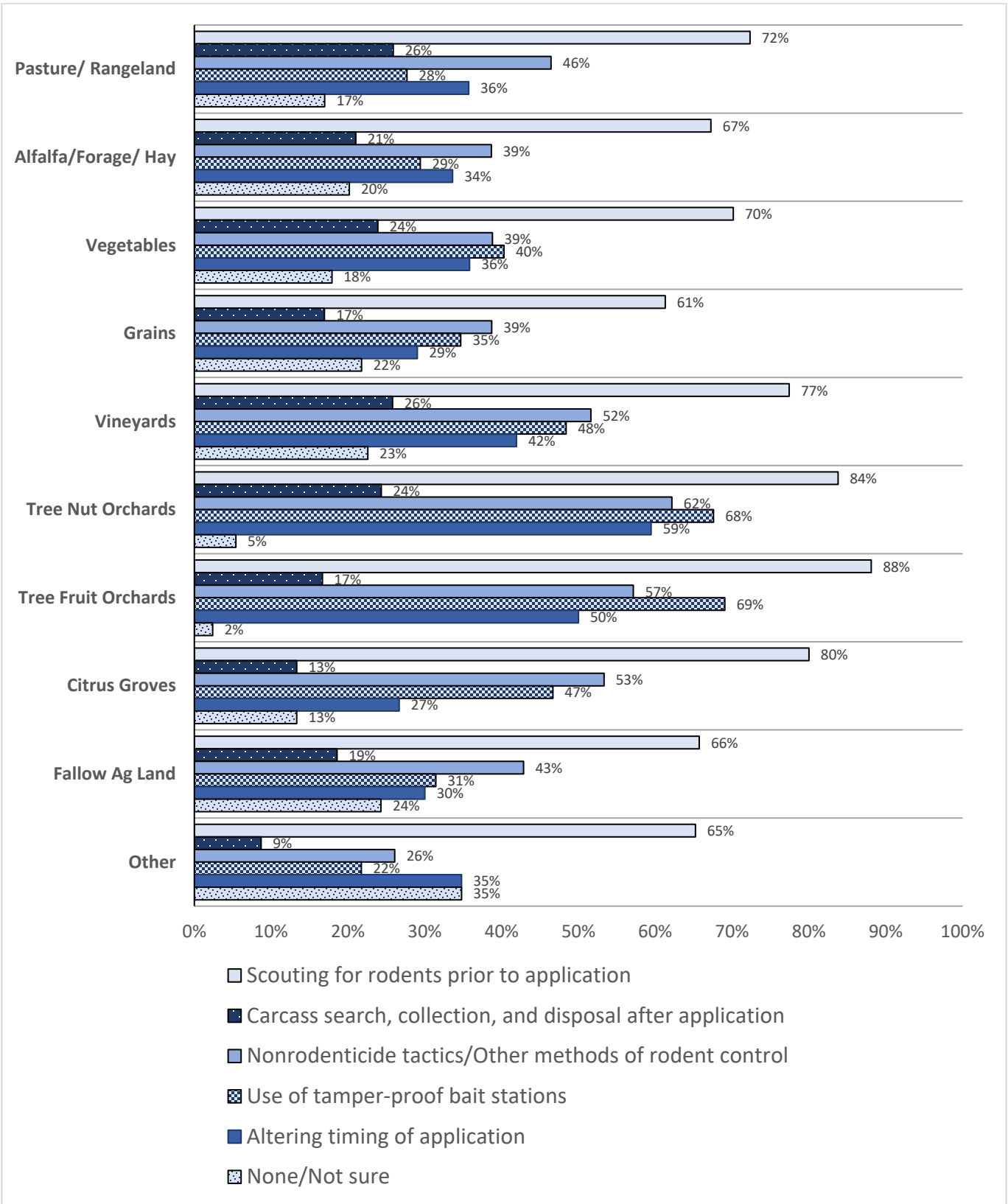

Figure 14. Percent of rodenticide users who reported using practices to manage nontarget exposure to rodenticides over the past 5 years by use site. Note: Survey question was limited to rodenticide users (n=181). **Survey Question:** *In the past 5 years, were any of the following practices used to manage exposure of nontarget organisms to rodenticides? Select all that apply.*

Mitigation Impacts

USDA asked respondents who used rodenticides about the likely challenges associated with the nationwide mitigation EPA has proposed for agricultural field-uses of chlorophacinone, diphacinone, zinc phosphide, and strychnine. Respondents were also asked about the challenges expected from the additional pilot species mitigation that EPA has proposed to mitigate risk to endangered species in anticipation of Endangered Species Act (ESA) assessments that are forthcoming for these AIs. The vast majority of respondents who use rodenticides reported that EPA's proposed mitigations would likely result in a number of challenges and substantial compliance costs (95 percent of rodenticide users). Less than 5 percent of rodenticide user respondents who answered these questions reported no foreseen challenges with any of the proposed mitigation. EPA's proposed mitigations are listed in the table below along with the percent of rodenticide user respondents who reported that they would face likely challenges if the proposed mitigation were implemented (Table 2). Overall, carcass search and disposal was the nationwide mitigation that respondents most frequently reported would likely cause challenges (88 percent of rodenticide user respondents reporting one or more issues with this mitigation) (Table 2). Specifically, the most commonly reported anticipated impacts from increased carcass search and disposal were increased labor costs (78 percent) and shortage of labor (64 percent) (Figure 15). One respondent commented:

> *"The carcass search will be the biggest barrier for the cropping systems I work with. For broadcast baiting in grass seed we have a short window after harvest to bait and thousands of acres are spread in a short amount of time. It will be impossible to thoroughly check fields for carcasses, much less visit each field at the frequency proposed."*

Rodenticide user respondents also anticipated challenges with the proposed prohibitions of chlorophacinone and diphacinone applications during the growth period to field edges (84 percent) and in-field (81 percent) (Table 2). Over half of rodenticide user respondents reported that these proposed mitigations would likely result in loss of rodent control (52 percent and 53 percent respectively), and nearly half reported that the proposed mitigations would make chemical rodenticide products unusable (43 percent and 45 percent respectively) (Figure 16). Pasture/rangeland/fallow land respondents anticipated similar impacts from the proposed prohibition of all above ground applications of chlorophacinone and diphacinone in pasture/rangeland (84 percent) (Table 2). In these sites, the most frequently reported anticipated challenge was not loss of rodent control or making the product unusable, although those challenges still rated highly (42 percent and 44 percent respectively), but rather that the proposed mitigation would greatly increase labor costs (57 percent) (Figure 17). One respondent commented:

> *"These EPA proposed changes would cost producers millions of dollars and make it so rodents could put them out of business."*

Rodenticide users also anticipated challenges associated with the mitigation proposed to reduce nontarget exposure risk to listed endangered species. Although the mitigation currently proposed by EPA only applies to three pilot endangered species (Stephen's Kangaroo Rat, Atwater's Prairie Chicken, and California Condor) and their range/critical habitat, USDA understands EPA intends to add similar mitigation for other endangered species in other locations in the future. As with the proposed nationwide mitigation to all field-uses, the proposed ESA-type mitigation requiring even greater carcass search and disposal efforts generated the most reports of anticipated challenges, with 96 percent of rodenticide users reporting one or more anticipated challenges from this mitigation (Table 2). Again, increased labor costs

(87 percent) and shortage of labor (63 percent) were the most commonly reported anticipated challenges with increased carcass search and disposal specifically for protection of endangered species (Figure 18). Proposed mitigation that would require use of bait stations modified to exclude listed species generated similar reports of anticipated challenges (93 percent of rodenticide users reported one or more anticipated impacts from this mitigation) (Table 2). Respondents reported that required use of modified bait stations would likely increase equipment costs (70 percent) and labor costs (50 percent), and approximately half of respondents (45 percent) reported that this mitigation would make products unusable. Rodenticide users reported similar anticipated challenges with the proposed prohibition of below ground applications in species range/critical habitat (91 percent of rodenticide users reported one or more anticipated impacts), indicating that the mitigation would likely increase labor costs (45 percent) and/or make products unusable (55 percent) (Figure 18). As one respondent explained, *"broad regulatory restrictions are not without real consequences."* The percent of rodenticide user respondents reporting impacts for each proposed mitigation is provided below in Table 2 and Figures 15–18.

Table 2. Percent of rodenticide users reporting anticipated challenges as a result of the proposed mitigations.

Proposed mitigation	Number of respondents reporting foreseen challenges with proposed mitigation	Percent of respondents for this mitigation reporting one or more foreseen challenges
All field-use mitigations for chlorophacinone, diphacinone, zinc phosphide, and strychnine (n=188)		
Carcass search, collection, and disposal	166	88%
All field-use products made Restricted Use Pesticides (RUP)	128	68%
Require PF-10 respirators and gloves for all field applications	114	61%
Additional mitigations specific to chlorophacinone and diphacinone to cropland (n=176)		
Field-edge during growth period: Prohibition of above ground scatter/spot, broadcast, and below ground applications	147	84%
In-field during growth period: Prohibition of above ground scatter/spot, broadcast, and below ground applications	142	81%
Prohibit aerial application	100	57%
Additional mitigations specific to chlorophacinone & diphacinone in pasture/rangeland/fallowland (n=146)		
Prohibition of above ground applications	123	84%
Additional restrictions proposed to mitigate risks to endangered species (n=182)		
Increased carcass search, collection, and disposal	174	96%
Required use of modified bait stations designed to exclude listed species	169	93%
Do not apply below ground into rodent burrows	165	91%
Do not apply via broadcast application in species range and critical habitat	155	85%
Do not apply via broadcast application within buffer from species range and critical habitat, based on application method and wind direction	151	83%

Survey Question: *Nationwide restrictions proposed to mitigate risk to human health and the environment: EPA has proposed the following mitigation measures to various agricultural field-uses of the rodenticides covered in the Preliminary Interim Decision (PID). Please indicate the likely challenges associated with the proposed mitigations—All field-use mitigations for chlorophacinone, diphacinone, zinc phosphide, and strychnine; Additional field-use mitigations specific to chlorophacinone and diphacinone. Additional rangeland/pasture/fallowland mitigation specific to chlorophacinone and diphacinone; Additional restrictions proposed to mitigate risk to endangered species: EPA has proposed specific mitigation to protect three endangered species (Stephen's Kangaroo Rat, Atwater's Prairie Chicken, and California Condor). While the current proposed mitigation is limited to these species in their range/critical habitat, EPA intends to add similar mitigation for other endangered species in other locations in the future. Please indicate the likely challenges associated with this type of mitigations. Select all likely challenges that apply.*

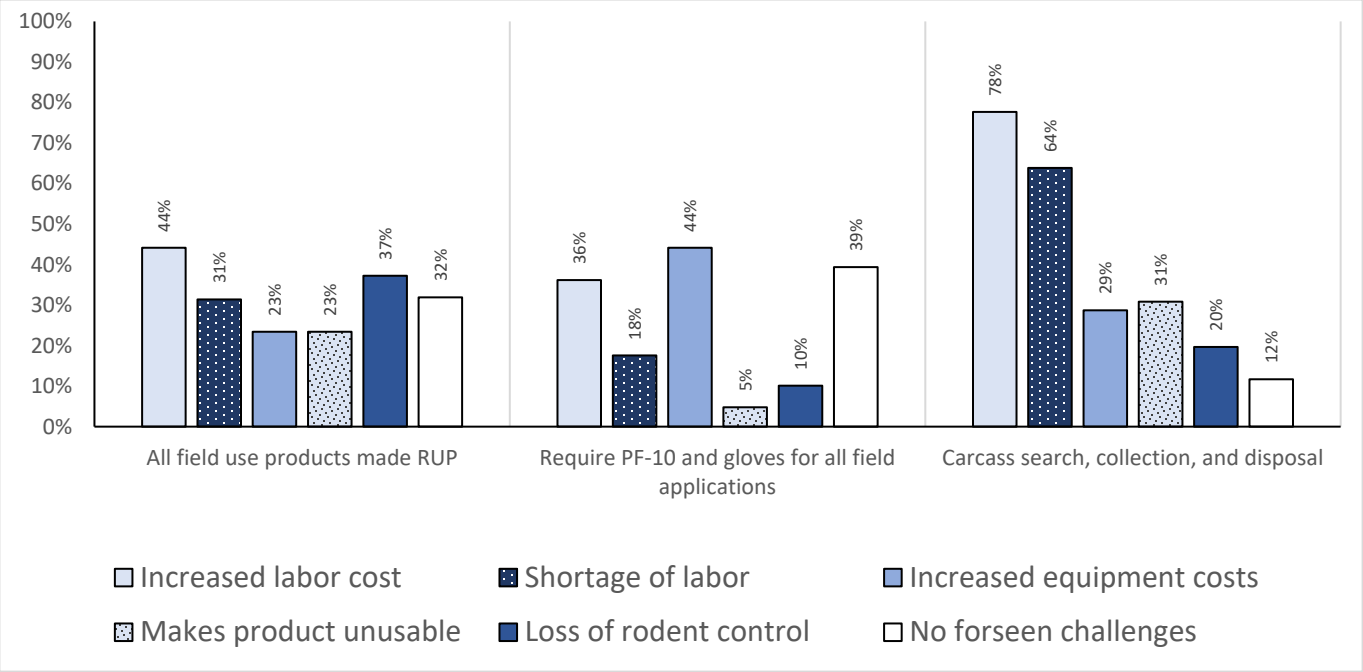

Figure 15. Percent of rodenticide users who reported anticipated challenges with mitigation proposed for all active ingredients and all field use sites (n=188). **Survey Question:** *Nationwide restrictions proposed to mitigate risk to human health and the environment: EPA has proposed the following mitigation measures to various agricultural field-uses of the rodenticides covered in the Preliminary Interim Decision (PID). Please indicate the likely challenges associated with the proposed mitigations—All field-use mitigations for chlorophacinone, diphacinone, zinc phosphide, and strychnine. Select all likely challenges that apply.*

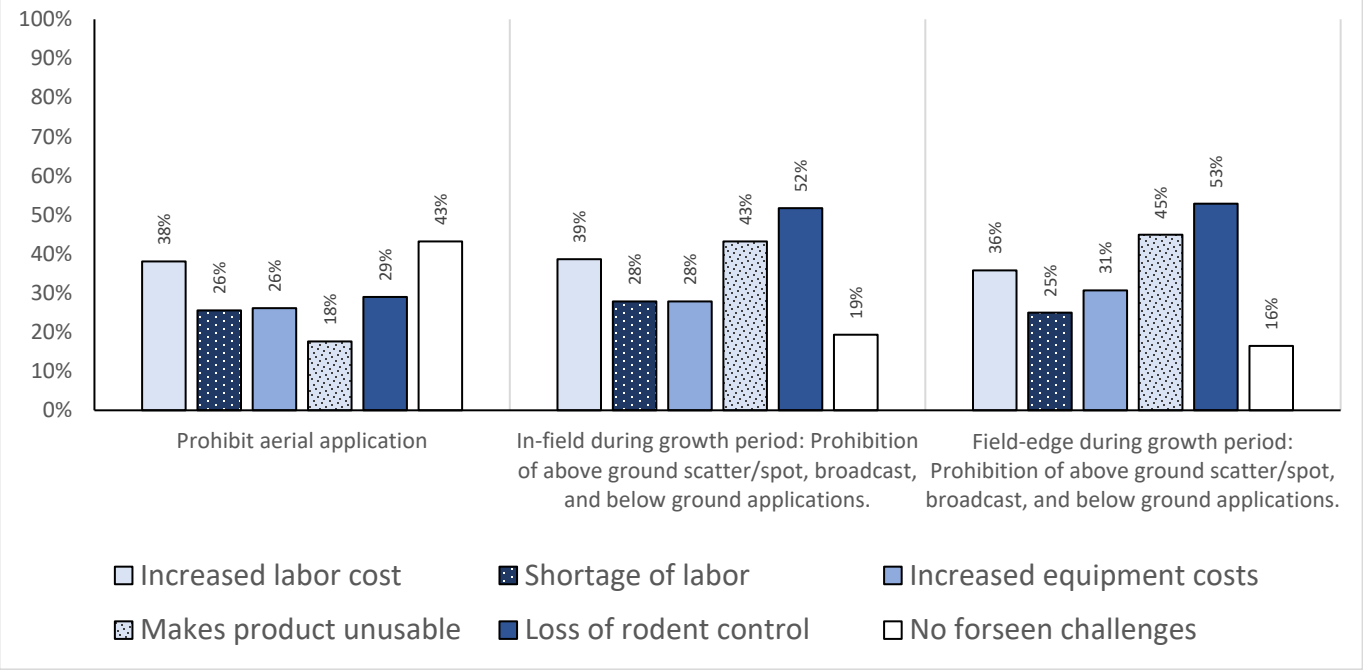

Figure 16. Percent of rodenticide users who reported anticipated challenges with mitigation proposed for chlorophacinone and diphacinone on crop uses (n=176). **Survey Question:** *Nationwide restrictions proposed to mitigate risk to human health and the environment: EPA has proposed the following mitigation measures to various agricultural field-uses of the rodenticides covered in the Preliminary Interim Decision (PID). Please indicate the likely challenges associated with the proposed mitigations—Additional field-use mitigations specific to chlorophacinone and diphacinone. Select all likely challenges that apply.*

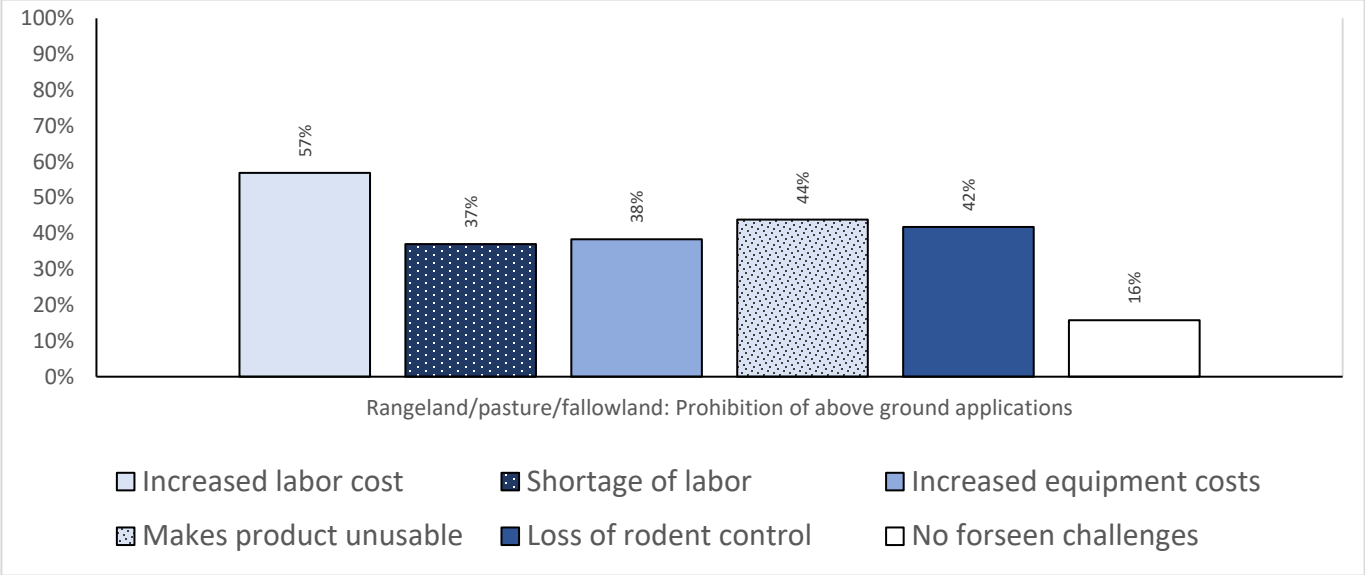

Figure 17. Percent of rodenticide users who reported anticipated challenges with mitigation proposed for chlorophacinone and diphacinone on pasture/rangeland/fallowland (n=147). **Survey Question:** *Nationwide restrictions proposed to mitigate risk to human health and the environment: EPA has proposed the following mitigation measures to various agricultural field-uses of the rodenticides covered in the Preliminary Interim Decision (PID). Please indicate the likely challenges associated with the proposed mitigations. Additional rangeland/pasture/fallowland mitigation specific to chlorophacinone and diphacinone. Select all likely challenges that apply.*

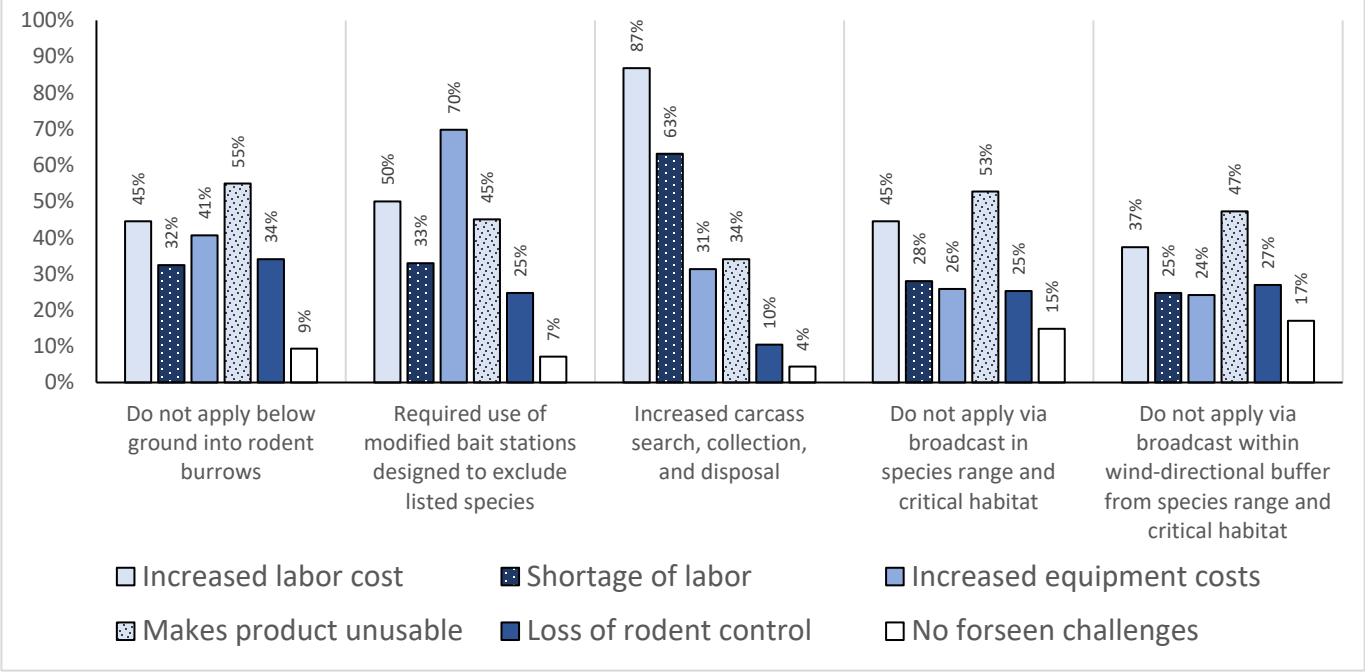

Figure 18. Percent of rodenticide users who reported anticipated challenges with mitigation proposed to protect pilot endangered species for all active ingredients and use sites in pilot species range and critical habitat (n=182). **Survey Question:** *Additional restrictions proposed to mitigate risk to endangered species: EPA has proposed specific mitigation to protect three endangered species (Stephen's Kangaroo Rat, Atwater's Prairie Chicken, and California Condor). While the current proposed mitigation is limited to these species in their range/critical habitat, EPA intends to add similar mitigation for other endangered species in other locations in the future. Please indicate the likely challenges associated with this type of mitigations. Select all that apply.*

Optional Feedback

USDA also requested optional free-text feedback from respondents on the proposed mitigations. Several themes emerged in these comments. Representative quotes are presented below.

Food Safety and Public Health

One major theme from these comments was the need for robust rodent control methods, including chemical rodent control, to ensure food safety and protect public health.

> *"In order for our farmers to comply with food safety requirements under FSMA [Food Safety Modernization Act] they need all tools available to them."*
>
> *"[Additional potential impacts from proposed mitigation include] GAP [Good Agricultural Practice certification] infraction around storage areas and bin areas, […] and potential of diseases transmitted from rodents."*
>
> *"These products [chemical rodenticides] and their current use save lives! GAP says these need to be implemented for compliance."*
>
> *"[Rodent] excrement in orchards and fruit bins, [leads to] higher chances of disease and sickness to the public."*

Climate-Smart Agricultural Practices

Another main theme that emerged was the roll of chemical rodent control in the implementation and maintenance climate-smart agricultural practices such as no-till and cover cropping.

> *"As ag producers are adopting conservation methods such as no-till and cover crops, they are creating even more winter habitat [for rodents]. They can hardly be asked to adopt conservation practices while at the same time have pest controls removed."*
>
> *"Rodent populations have increased substantially due to climate changes and environmentally friendly agricultural practices."*
>
> *"Increased use of cover crops in no-till situations will increase the need for rodenticides."*
>
> *"[Without rodenticides] growers stop no-tilling or using cover crops which is detrimental to the environment."*

Population control

Another key theme centered on the potential of rodent populations to quickly multiply due to lack of control and move from one operation to another. Rodent populations can greatly increase in one breeding cycle, and populations can migrate to neighboring farm operations. Respondents stated:

> *"We have a problem with [ground squirrels] moving from nut orchards into vegetable fields, which can result in the loss of entire vegetable fields from rodent infestations in food crops."*

"Farming next to organic growers is difficult. They don't control their gophers since they can't use any [rodenticides]. The gopher population is exploding in conventional farms next to these organic growers."

Conclusion

The results of this survey highlight the key role of chemical rodenticides for rodent control in outdoor agricultural production and the likely challenges associated with EPA's proposed mitigation. The majority of respondents that reported using chemical rodenticides used them in conjunction with other control methods as part of an integrated pest management strategy for rodent control. Additionally, respondents indicated that the overall proportion of operations treated with rodenticides is low, but that rodenticides are critical tools when needed. Reported chemical rodenticide usage was higher in perennial crops (vineyards, orchards, groves), which is likely attributable to the disproportionately high rodent pressure faced by these operations and the inability to utilize mechanical rodent control alternatives such as tilling. The survey also found that a range of application methods, application timings, and bait placements are used to control the spectrum of rodent pests targeted by rodenticides across different outdoor agricultural settings.

Survey respondents reported that EPA's proposed mitigation measures, as currently outlined, could lead to labor shortages, increased costs, and loss of rodent control. Furthermore, the survey results indicated that rodenticide users already commonly employ multiple strategies to manage nontarget exposure to rodenticides, and that additional use restrictions could preclude the use of these tools in certain settings. Optional written feedback conveyed the need for effective rodent control to maintain a safe, affordable food supply and that chemical rodenticides in particular are essential to the viability of certain climate-smart agricultural practices.