

## Statistical Methodology

**Name of Survey:** Vegetable Chemical Usage

**Name of Summary:** Agricultural Chemical Usage, 2022 Vegetable Crops Summary (*Access at USDANASS Quick Stats 2.0: <http://quickstats.nass.usda.gov/>. See Program: Survey, Sector: Environmental, Group: Vegetables, Commodity: Select the vegetable(s) you want data for*)

**Data Collection Period:** September 2022 to January 2023

**Target Population:** The target population for the vegetable chemical use survey is the official USDA farm population, within the pre-defined program states, which is defined as “all establishments that sold or would normally have sold at least \$1,000 of agricultural products during the year,” excluding abnormal or institutional farms.

Program states are selected to both minimize the total number of states selected and ensure at least 80 percent coverage of target commodity acreage.

**Sample Size, Sampling Frames, and Sampling Method:** There were 3,893 samples drawn from the NASS List Sampling Frame for the Vegetable Chemical Use Survey. The Vegetable Chemical Use Survey (VCUS) sample is selected as a follow-on survey to the Integrated Screening Survey. Operations that responded to having the target crops of interest on a screening survey were eligible to be sampled for the 2022 VCUS. The Integrated Screening Survey (ISS) sample is selected from the NASS list frame using Sequential Interval Poisson Sampling to minimize overlap between the current year’s ISS sample, last year’s ISS sample, and other NASS surveys. The sample design for VCUS is Multivariate Probability Proportional to Size (MPPS). In MPPS, the maximum of the probabilities of selection over all of the target crops that an operation grows is used in combination with the desired sample sizes for each crop to draw the sample. The larger the operation’s maximum probability is, the larger the operation’s chance of being selected for the sample.

VCUS is a two-phase sample design. In Phase 1, the screening phase, list frame control data are used to determine the probabilities of selection. The operations selected in Phase 1 are interviewed in the Integrated Screening Survey to determine if they are growing any of the crops of interest and the number of acres planted. In Phase 2, the results from the Integrated Screening Survey are used to select the final sample for the survey. Both the Phase 1 and Phase 2 sample selections use MPPS designs.

In Phase 2, operations with multiple operating arrangements are sub-sampled. Only the sub-sampled operations are contacted for data collection.

**Sample Unit and Reporting Unit:** The vegetable chemical use survey is a list sampling frame only survey. The operator of the sampled farm was personally interviewed to obtain information on chemical application made to each targeted vegetable crop on the farm.

**Modes of Data Collection:** Personal visit from an enumerator.

## Selected Terms and Definitions

**Active Ingredient:** The specific pesticide ingredient which kills or controls the target pest(s) or other target material(s), or otherwise results in the pesticide effect(s). All pesticide-use estimates in report are published per active ingredient (rather than per product); one or more active ingredients are present in known amounts in the pesticide products reported in survey.

*Rate* and *Total Applied* estimates were reported in a single unit of equivalence, per active ingredient. For salt, ester, or amine active ingredients, estimates were published in the parent acid equivalents. For example, the acid derivatives glyphosate isopropylamine salt and 2,4-D, 2-ethylhexyl ester were published in the glyphosate and 2,4-D equivalents, respectively. For copper compounds, estimates were published in the metallic copper equivalent.

**Active Ingredient Code:** A unique code assigned to each active ingredient upon registration with the Environmental Protection Agency's Office of Pesticide Programs, to facilitate pesticide regulation.

**Area Applied, Percent:** Percent of total planted acres which received one or more applications of a specific fertilizer nutrient or pesticide active ingredient. (*In Quick Stats: Treated, Measured as Percent of Area Planted*)

**Avoidance:** A strategy in which the detrimental effects of pests on crops are mitigated or eliminated solely through various cultural practices. Avoidance is one of four classes of pest-management practices for which data are included in the report.

**Beneficial Insects:** Insects (small invertebrate animals, mostly of arthropod classes Insecta and Arachnida), which are collected and introduced onto crop acres because of their value in biological control as predators on harmful insects and parasites.

**Chemigation:** Application of agricultural chemicals, including pesticide products, by injection into irrigation water.

**Crop Year:** The period starting immediately after harvest of the previous year's crop and ending at harvest of the current year's crop.

**Farm:** Any place from which \$1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the year. Government payments are included in sales.

**Fertilizer:** A soil-enriching agricultural input which contains one or more plant nutrients. Data for three primary macronutrients nitrogen (N), phosphate ( $P_2O_5$ ), and potash ( $K_2O$ ), and the secondary macronutrient sulfur (S) are included in report.

**Fungi:** Various organisms of the kingdom Fungi, which obtain nutrients by decomposing plant or other organic life. This pest group includes mushrooms, molds, mildews, smuts, rusts, and yeasts. Fungal infestations have the potential to reduce crop production and/or lower the grade quality of the host crop.

**Mechanism of Action (MOA):** The method or biological pathway by which the pesticide or active ingredient kills or controls the target pest(s) or other target material(s).

**Monitoring:** A strategy involving the observance or detection of pests through systematic sampling, counting, or other forms of scouting. Monitoring may include prediction of pest population levels through the observance of environmental factors such as weather or soil and crop quality. Monitoring is one of four classes of pest-management practices for which data are included in the report.

**Nematodes:** Unsegmented, parasitic worms of the phylum Nematoda. Prominent animal pest of wheat and other field crops with the potential to be highly destructive, lowering crop production and grade quality significantly.

**Number of Applications:** The average number of times a treated acre received a specific fertilizer nutrient or pesticide active ingredient. (*In Quick Stats: Applications, Measured in Number*) **Pesticide:** Defined by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as “(1) any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and (3) any nitrogen stabilizer...”(*Title 7, U.S. Code, 136*). Under FIFRA, pesticides are registered and regulated through the Environmental Protection Agency’s Office of Pesticide Programs. Four classes of pesticides are included in report: (1) herbicides targeting weeds, (2) insecticides targeting insects (3) fungicides targeting fungi, and (4) other chemicals targeting all other pests or other materials (including extraneous crop foliage).

**Pheromone:** A chemical substance produced by an insect which serves as a stimulus to other individuals of the same species for one or more behavioral responses.

**Prevention:** A strategy in which a pest population is kept from infesting a crop or field, by taking various preceding actions. Prevention is one of four classes of pest-management practices for which data are included in the report.

**Rate per Application:** Ratio indicating pounds (lbs) of a fertilizer primary nutrient or pesticide active ingredient (or associated acid or metallic equivalent) applied, per single application, per planted acre. (*In Quick Stats: Applications, Measured in Lb/Acre/Application*)

**Rate per Crop Year:** Ratio indicating pounds (lbs) of a fertilizer primary nutrient or pesticide active ingredient (or associated acid or metallic equivalent) applied, counting all applications per crop year, per planted acre. (*In Quick Stats: Applications, Measured in Lb/Acre/Year*)

**Suppression:** A strategy which involves the control or reduction of existing pest populations in order to mitigate crop damage. May include physical or biological controls, or management of resistance build-up through pesticide rotation. Suppression is one of four classes of pest-management practices for which data are included in the report.

**Data Review and Estimation Procedures:** Headquarter (HQ) statisticians execute a summary that generates program state level indications. Regional Field Offices are responsible for performing a detailed review of their survey results and providing comments that justify their survey results. HQ statisticians conduct a final review of survey results from all program states. Any irregularities revealed by the summary must be investigated and, if necessary, resolved. After final review, state and program state level summary results are adopted as official estimates.

There are three main types of data that NASS estimates for these surveys - fertilizer application, pesticide application, and pest management data. For the application data, NASS collects information about the commercial fertilizers and pesticides applied during the crop year. For fertilizer, these applications are collected as either actual pounds or percent analysis of Nitrogen (N), Phosphate (P<sub>2</sub>O<sub>5</sub>), Potash (K<sub>2</sub>O), and Sulfur (S). Fertilizer data are then published in actual pounds of nutrient used. For pesticides, these applications are collected at the product level, generally per application. These product level data are converted to pounds of active ingredient (or the acid or metallic equivalent, where applicable), summarized, and published. If there are not a sufficient number of reports, the data are suppressed from publication, along with any needed complementary suppression. Indications were published if five or more reports were received and summarized for a given variable and if the indication was greater than or equal to one half of the pre-determined rounding unit for that variable. NASS maintains chemical use

databases which contain pesticide product recommended use ranges and active ingredient concentrations per product. These databases are used to review pesticide product usage data.

Estimates are calculated and published at the population-level using official USDA-NASS 2022 acreage estimates by State (published in the annual NASS report “Vegetables – 2022 Summary” [ISSN: 0884-6413]). For this reason, all published estimates apply at the population-level defined by these official estimates. Note that although official USDA-NASS crop acreage estimates are subject to revision, the chemical use estimates are not subject to revision.

For both fertilizer and pesticide application data, NASS estimates area applied (percent of planted acres treated), number of applications, rate per application (pounds of active ingredient or acid equivalent per acre), rate per crop year (number of applications multiplied by rate per application), and total amount applied.

The standard deviation for each active ingredient is calculated to determine data distribution for each crop. Chemical distribution rates are given by active ingredient for the percent of acres treated, number of applications, rate per application, and rate per crop year. Rate distribution tables include the median, the 10th and 90th percentiles, the mean, and the coefficient of variation (CV) for an active ingredient when a sufficient number of farm operators report applying it on the specified crop. Distribution and reliability measures were published if 30 or more reports were received and summarized for a given variable.

The pest management data are generally a series of yes/no questions pertaining to specific pest management practices. Pest management data are collected for the randomly chosen field. From these data, NASS releases the percent of operations using the practice as well as the percent of acreage. The percent of acreage assumes that the operation treats all fields of a particular commodity in the same way.

**Reliability:** Estimates were subject to sampling variability; sampling variability was measured by the coefficient of variation (CV), expressed as a percent of the estimate. Coefficients of variation were derived and published for *Percent Treated*, *Number of Applications*, *Rate per Application*, and *Rate per Crop Year* pesticide-usage variables. In general, a lower CV indicates a more precise estimate. Coefficients of variation differed considerably by variable, chemical, and crop. The narrower the numerical range of responses per variable and the larger the number of positive responses per variable, the smaller the sampling variability. For these reasons, CVs were generally lower for active ingredient *Rate of Application* estimates and for estimates associated with the most often reported active ingredients. (Application rates reported almost always fell within the manufacturer’s relatively narrow recommended usage range, and a relatively large number of reports were received for the most widely used active ingredients).

Estimates were additionally subject to non-sampling errors. These errors include reporting, recording, editing, and imputation errors. Steps are taken to minimize the impact of these errors, such as comprehensive interviewer training, validation and verification of processing systems, detailed computer edits, and the analysis tool. Re-contact with respondents is conducted on an as needed basis.

**Revision Policy:** Estimates are final at first publication and are not subject to revision.