HHRA
Heartland Health Research Alliance

Pesticide Use Metrics

Extent of Use: Metrics 1-7

Pesticide impacts on the environment and human health are clearly a function of how widely and often a pesticide is applied, in addition to the rate at which it is applied.

It is also important to take into account how widely and frequently a pesticide is used on a given farm, on a crop, and/or across all crops in a region.

Seven metrics are needed to track the frequency and extent of use of a given pesticide:

1. **"Percent Acres Treated"** is the percent of the acres of a given crop in a region that is treated with a given pesticide.
2. **"Number of Acres Treated"** is the number of acres of the crop treated one or more times with a given pesticide, calculated as the (percent acres treated) multiplied by (total crop acreage).
3. **"Acre-Treatments"** takes into account both the percent of acres treated and the average number of applications with each active ingredient applied, and is calculated as (acres treated) multiplied by (number of applications) made with a given pesticide.
4. Average **"One-time Rate of Application"** of active ingredient on an acre/hectare of a given crop.
5. Average **"Number of Applications"** made with a specific active ingredient on a crop in a production cycle (usually a calendar year).
6. **"Rate per Crop Year"** is the average rate of application per production cycle, and is calculated as (average one-time rate of application) multiplied by (average number of applications).
7. **"Pounds Applied"** is the total pounds of active ingredient applied per production cycle on a given crop, or across all crops or sets of related crops (i.e., fruits or small grains).

Measures of Reliance on Low-Dose and High-Dose Chemistry: Metrics 8-12

Additional metrics are needed to gain deeper insight into how changes in one-time rates of application impact trends in overall pesticide use.

This is because, since the early 1980s, the pesticide industry has focused on identifying new modes of action that are highly specific to target pests and usually effective at low, or very-low dose rates.

Such active ingredients typically target specific metabolic, biochemical, physiological, developmental, or reproductive processes in target pests. Several are applied at very low rates, which bring down measures of overall pounds of pesticides applied per acre, in a region, or on a given crop.

But shifting acres treated from one or a few relatively high-dose pesticides to multiple low-dose active ingredients (a.i.s) can make intensification of pesticide use appear to be a reduction in use.

Five additional metrics are useful in coaxing out the impact of changes in average rates of application over time:

8. **"Number Low-Dose Chemistry"** is the number of a.i.'s applied at a rate <= 0.1 pound/acre.
9. **"Reliance on Low-Dose Chemistry"** is the percent of acres treated with an a.i. applied at a rate <= 0.1 pound/acre.
10. **"Number High-Dose Chemistry"** is the number of a.i.'s applied at a rate =>1.0 pound/acre.
11. **"Reliance High-Dose Chemistry"** is the percent of acres treated with an a.i. applied at a rate =>1.0 pound/acre.
12. **"Weighted Average Rate of Application"** is the average rate of application per acre treatment across all pesticides applied within a category of pesticides (i.e. herbicides/insecticides/fungicides), weighted by each pesticide's share of total acre treatments.

Metric 12 is the best way to track the overall impact of changes in average rates of application. This key indicator, coupled with trends in the average number of acre-treatments on any given acre, provide the most reliable empirical assessment of changes in the intensity of pesticide use on a given crop.

It is worth highlighting that most of the widely used, high-dose pesticides applied by farmers in the 1980s have been replaced in the intervening years by moderate, low, or very low-dose active ingredients. As a result, pounds of a.i. applied have declined, whether measured per acre, by crop, or across all crops.

But unfortunately, this reduction does not mean that farmers have become less reliant on pesticides.

Use By Type of Pesticide: Metrics 13-18

The above 12 metrics represent a "Minimum Data Set" (MDS) for assessing use of a specific pesticide on a given crop in a given year. This MDS can be applied to a pesticide applied on a field, on all acres of a specific crop on a farm, and/or all acres producing a crop across all farms in a county, state, province, region, nation, continent, or worldwide.

The impacts of annual pesticide use on farm production costs, the environment, the emergence and spread of resistant pests, and public health are driven by the total number, volume, environmental fate, and toxicity of the pesticides that are applied. Accordingly, additional pesticide use metrics are needed to take into account how many different pesticides are needed to bring a crop to harvest in a given production cycle, as well as the differing properties of specific pesticides.

Typically, pesticide use data and trends are studied by major type of pesticide, and the categories of pests targeted by pesticides. The three major categories, and their corresponding type of pesticide, are: weeds (herbicides), insects (insecticides), and plant diseases (fungicides). These three major types of pesticides are referred to herein as H/I/F/O, with the "O" referring to all "Other" types of pesticides (e.g., desiccants, rodenticides, fumigants).

For each type of pesticide, there are three essential metrics needed to account for aggregate pesticide use within a given type of pesticide. These can be quantified per acre, on a field, across all fields on a farm, and/or in a county, state, region, nationally or globally:

13. **"Number of H/I/F/O AI's Applied"** is the number of different pesticide active ingredients applied on a given crop in a specific region and year combination (e.g. number of different herbicide active ingredients applied on soybeans in Iowa in 2015).
14. **"Number H/I/F/O AI's per Acre"** is the average number of H/I/F/O active ingredients applied per acre.
15. **"Number of H/I/F/O Acre-treatments"** is the total number of acres treated with a distinct H/I/F/O active ingredient (e.g., one application of a tank-mix containing three active ingredients counts as three acre-treatments).
16. **"H/I/F/O Acre-Treatments per Acre"** is the total number of acre-treatments divided by the number of acres planted.
17. **"Pounds of H/I/F/O Applied**" is the sum of pounds a.i. applied across all pesticides within a type of pesticide in a given crop year/region combination.
18. **"Pounds H/I/F/O per Acre"** is total pounds applied divided by total acres planted.

Over the last several decades in most years and regions, farmers have managed weeds, insects, and plant diseases with one or two active ingredients on most fields, and often none.

Until very recently, soybeans grown in the U.S. were almost never treated with fungicides or insecticides, and corn was rarely treated with fungicides.

But nearly 100% of the conventionally managed acreage of both crops has been sprayed with herbicides annually. For decades, most conventionally managed fruit and vegetable crops, on the other hand, have been sprayed with 1-3 herbicides, 2-5 insecticides, and 2-4 fungicides, and for many crop-region combinations, markedly more.

For example, potato farmers in 2016 sprayed an average of 5.95 fungicide active ingredients, but because several fungicides were applied multiple times, there were a total of 12.5 fungicide acre-treatments on the average acre of potatoes.