Applied Mythology

What if much that you think you know about agriculture, farming and food isn't actually true? What if there are "myths" that have been intentionally and mostly unintentionally spread about these issues? What if the truth about these issues matters for the future of humanity? That is what this blog is about. If you are interested in learning more about my business as a public speaker, please visit my website, drstevesavage.com.

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Five Ways Farmers Control Pests Other Than With Pesticides

There are many pests in the world which attack plants or compete with them for the resources they need to grow. This is true for plants growing in natural stands, but also for the plants that people grow as crops. If pests are left unchecked, crop productivity is compromised. Without good pest control, it would take a lot more land to feed humanity - land we simply don't have. Pest damage can also compromise the storage or shelf-life of foods leading to more wasteful inefficiencies. Pests can also make foods dangerous through the production of mycotoxins (see contaminated corn below)

Corn infected with Aspergillus flavus can be contaminated with one of the more toxic and carcinogenic chemicals known

One way that farmers prevent these problems is with the use of pesticides, and this is true in both organic and conventional production systems. However; farmers also control pests in many ways other than using pesticides. These tools and strategies differ based on the crop and the geography where it is grown, but they include at least the following five categories:

1. Avoiding the pest
2. Finding genetic resistance
3. Modifying the climate
4. Disrupting the pest's life cycle
5. Fostering beneficial organisms

1. Avoiding The Pest

Not all pests occur in all places. Pests like insects and diseases have co-evolved with the plant species that they are able to attack, often in the geography where the crop was first domesticated. Sometimes by moving the crop to a new location, the pest can be avoided. This happened several times with coffee rust and with potato late blight when that crop was first brought to Europe from S. America. Eventually the pest tends to catch up, and with the intensity of modern travel, pest redistribution is inevitable. The more stable way to avoid a pest is to grow the crop in a new climate that does not favor the pest. When fruit and vegetable crops are grown in Mediterranean climates (e.g. California, Italy, Spain...) where there is little or no rain in the growing season, many diseases are avoided. This of course requires irrigation, but if that is done with subsurface drip, weed growth is also largely avoided (see below).

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Chardonnay Grapes in Colorado

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Weeds in furrow-irrigated tomato field (left) compared to subsurface drip irrigation (top).

Another good example is the potato industry which is in the San Louis Valley of Colorado surrounded by high mountains. This isolates the crop from aphids and the viruses they spread and is particularly good for seed potato production.

2. Finding Genetic Resistance

Wheat stem rust is a potentially devastating disease that was successfully controlled using genetic resistance for several decades

One of the reasons for a concerted effort to maintain extensive seed banks is to maintain the genetic diversity in a crop which may include resistance traits to various pests. For instance, when the resistance to wheat stem rust was finally overcome by the UG99 strain of that fungus, wheat breeders went to the seed banks to find a new resistance gene and have been cooperating internationally to get that trait bred into the myriad types of wheat grown around the world. There are also often genetic solutions for soil-borne pests which involve grafting the desirable type of a fruit or vegetable onto a rootstock that provides resistance. This is most commonly used for perennial crops, but in recent times this sort of grafting for genetic resistance is also being used with tomatoes, cucumbers and even eggplants.

Genetic engineering provides a means of using genetic pest resistance in situations where ordinary breeding for such a trait is either impossible or far too slow. For instance there is a gene for resistance to a bacterial disease of peppers which has been moved to tomatoes making them resistant to that same bacterium. Potatoes are difficult to breed, but by transferring a gene from wild potatoes from the Andes, disease resistance has been moved into modern, commercial-type potatoes (see below).

Breeding resistance to coffee rust is possible, but doing that with conventional breeding methods will not be fast enough to help the small-holder coffee farmers whose way of life is now threatened by that disease. Unfortunately, the rich world part of the coffee industry has elected not to use genetic engineering to speed up that process.

Potatoes genetically engineered to resist late blight using a gene from their wild relatives

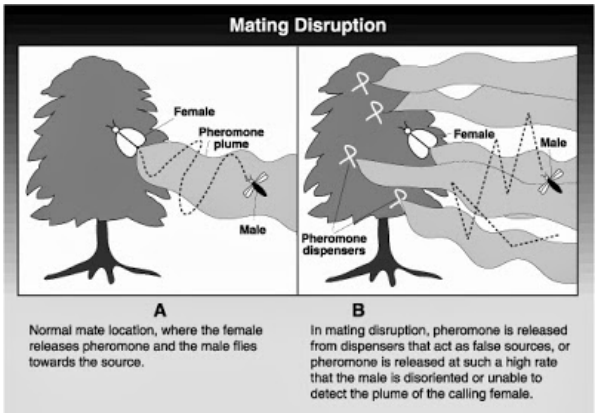
3. Modifying The Climate

Wine grape growers often use trellising methods and removal of lower leaves to change the microclimate where the grape clusters are developing. This helps to prevent a fungal disease called "Botrytis bunch rot." There are a whole range of growing practices called "protected culture" that range from a simple rain shield to a passive greenhouse to a high-tech greenhouse with complete climate control. These measures provide relief from certain diseases that would otherwise be fostered by rain. In some cases the system excludes insect pests all together (see below). Although this approach is too capital-intensive for many crops, it is very effective for high value vegetable and fruit crops and this is a rapidly growing segment of agriculture around the world.

Tomatoes grown without soil and protected from insect pests

4. Disrupting The Pest's Life Cycle

Perhaps the most common way that pests are controlled in annual crops is through the use of crop rotation. For instance, corn is typically rotated with soybeans throughout much of the midwestern US. This prevents population increases of certain pests because every other year certain pests don't have a suitable host available. For potatoes it is often necessary to have several seasons of other crops planted between each potato crop, otherwise pests become too damaging. Another way that insect pests can be controlled is through an approach called Mating Disruption.



Synthetic versions of the insect's mating hormones are placed throughout a field or orchard so that the males can't detect the gradient of that hormone which guides them to females.

In certain cases it is possible to release large numbers of male insects which have been intentionally raised and sterilized. These males then out-compete the wild ones to mate with the females and so very few offspring are generated within the population. For pests that are quite specific to a given crop and which don't succeed on other crops or weeds, it is possible to organize a time of year when no examples of that crop are growing throughout a given geographical area. The crop-free period results in a crash in the pest population.

5. Fostering Beneficial Organisms

Even pests have pests, and often there is a way to encourage those "natural enemies" sufficiently to keep crop pest populations at tolerable levels. For example, the cottony cushion scale was once a big problem in the California citrus industry, but the problem was greatly reduced once a natural predator of the scale called the Vidalea Beetle was introduced into the state.

Cottony Cushion Scale


Vedalia beetle

The grape leafhopper can be a very damaging pest, but when growers plant wild blackberry vines near their vineyards, they encourage the build-up of a certain kind of parasitic wasp which attacks the blackberry leafhopper species in addition to the grape leafhopper. This can keep the grape leafhopper numbers sufficiently low to make pesticidal control unnecessary. Some insect predators or parasitoids are raised commercially for release on farms. Some diseases and nematodes are controlled by applying biocontrol agents such as bacteria or fungi which act as hyperparasites. When potatoes were genetically engineered with a Bt protein to resist the Colorado Potato Beetle, farmers noted that secondary pests were no longer a problem because the natural enemies were no longer being killed by broader spectrum insecticides. Unfortunately, when fast food companies chose to use their leverage to end the growing of Bt potatoes, a resurgence of these secondary pests was one of the consequences.

Pest control in agriculture is a multi-dimensional effort, and pesticides are just one of the important tools, procedures and choices that farmers employ. Some of these tools have been in use for a very long time and some are new. With climate change, the control of pests will become even more difficult. As global population grows and standards of living increase, it will be even more important for farmers to avoid the sort of losses and food waste than can be caused by pests. Fortunately the tool box available is diverse and constantly improving.

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Image of corn with aflatoxin-producing Aspergillus flavus infection from Iowa State University IPM
Drip irrigated tomato image from safs.ucdavis.edu
Wheat stem rust images from USDA-ARS
Grafted tomato image from Wikimedia Commons
Engineered blight resistant potato image from The Sainsbury Laboratory
Vertically trellised grapevines with leaf removal image from Extension.org
High tech tomato greenhouse image from Wikimedia
Mating disruption graphic from WSU Tree Fruit Research and Extension Center
Cottony Cushion Scale image from Invasive.org
Vedalia beetle image from Wikipedia

Posted by Steve Savage at 10:20 PM

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