

Alfalfa Problem 1

Alfalfa is a very nutritious, perennial legume that contains high concentrations of several vitamins needed by dairy cattle. Weed infestations in alfalfa fields cause many problems for farmers: reduced crop yield, reduced crop quality, and more severe insect infestations. Alfalfa farmers use crop rotation, herbicides, and other practices to try to control weed infestation.



Possible Solution

Removing weeds by physical methods such as tilling can be time-consuming and expensive, so farmers often spray herbicides to destroy weeds. Farmers use less fuel because fewer passes are made through the field to till. However, a farmer can only spray herbicides on a crop if it is tolerant to the herbicide. Scientists have genetically engineered crop plants to be tolerant to certain herbicides. Use of herbicide-tolerant crops could help reduce environmental damage because they require less tilling. Less tilling can lead to reduced soil erosion.

Alfalfa Problem 2

Alfalfa is a very nutritious, perennial legume that provides food for dairy cattle. Alfalfa plant stems contain lignin, which is important because it provides strength for upright growth. The amount of lignin in the stems increases as the plants mature (grow). Since lignin is mostly indigestible by cows, this means that the quality of the alfalfa as a food decreases the longer the farmer waits to harvest it. The farmers have limited time during the growing season to harvest the alfalfa.



Possible Solution

Scientists have identified several genes that control the ability of the plant to produce certain lignin building blocks. Genetic engineering has been used to suppress these genes, which causes a slower rate of lignin production in the plant but does not affect the strength of the plant's stem. The reduced-lignin plant gives the farmer greater flexibility to decide when to harvest his crop to achieve high yields and good food quality. This results in better food efficiency and less manure production.

Apple Problem

Apples are a very important crop in the United States, the second largest producer of apples in the world. Biting and/or slicing into an apple damages the apple cells, and this causes a chemical reaction that turns the apple brown. The brown color is unappetizing to consumers who often throw the apples away rather than eating them. This results in wasted food.



Possible Solution

Researchers have discovered that by inserting extra pieces of several genes into a plant, they can turn off expression of the browning enzymes and thus prevent browning.

Canola Problem

The canola plant is cultivated for its seeds. The seeds are processed into high quality, edible oil that is used in many foods, and into high protein meal, which is desirable food for livestock, poultry and fish.



Weeds that grow among the canola plants compete for space, nutrients, and sunlight and ultimately can lead to significant crop yield losses and contaminate bulk seed at harvest. Weed control through herbicide application during the growing season improves the quantity and quality of the grain produced.

Possible Solution

Removing weeds by physical methods such as tilling can be time-consuming and expensive, so farmers often spray herbicides to destroy weeds. Farmers use less fuel because fewer passes are made through the field to till. However, a farmer can only spray herbicides on his or her crop if it is tolerant to the herbicide. Scientists have genetically engineered crop plants to be tolerant to certain herbicides. Use of herbicide-tolerant crops could help reduce environmental damage because they require less tilling. Less tilling can lead to reduced soil erosion.

Field Corn Problem 1

Corn is the premium food for cows, pigs, and chickens. Field corn is also used in the production of ethanol, an additive in gasoline, and a small portion is processed for use as corn cereal, corn starch, corn oil, and corn syrup for human consumption.



The corn borer, a moth that lays eggs on corn plants, is a serious pest. When the eggs hatch, the larva that looks like a small worm eats the corn plants and can cause millions of dollars of damage to the corn field.

Possible Solution

To make plants resistant to damage by insect pests, scientists have taken genes from the bacteria *Bacillus thuringiensis* (Bt) and inserted these into the plant. The genes make proteins that are toxic to the insect pests that eat the plants. Bt toxins are desirable pest control agents because they are non-toxic to humans, animals, or most other insects, but are highly effective against specific groups of pest insects. When ingested, Bt toxins act as gut poisons for the pest, causing susceptible insects to stop feeding and eventually die.

Field Corn Problem 2

Corn is the premium food for cows, pigs, and chickens. Field corn is also used in the production of ethanol, an additive in gasoline, and a small portion is processed for use as corn cereal, corn starch, corn oil, and corn syrup for human consumption.



Weed control is one of corn farmer's greatest challenges, because poorly controlled weeds drastically reduce crop yield and quality. Herbicides help increase yield, so they are an important part of commercial food production.

Possible Solution

Removing weeds by physical methods such as tilling can be time-consuming and expensive, so farmers often spray herbicides to destroy weeds. Farmers use less fuel because fewer passes are made through the field to till. However, a farmer can only spray herbicides on a crop if it is tolerant to the herbicide. Scientists have genetically engineered crop plants to be tolerant to certain herbicides. Use of herbicide-tolerant crops could help reduce environmental damage because they require less tilling. Less tilling can lead to reduced soil erosion.

Field Corn Problem 3

Corn is the premium food for cows, pigs, and chickens. Field corn is also used in the production of ethanol, an additive in gasoline, and a small portion is processed for use as corn cereal, corn starch, corn oil, and corn syrup for human consumption.



In some corn-growing regions of the United States, farmers can experience water shortages, sometimes caused by drought. Climate models suggest that drought will become more frequent in North America if the planet continues to heat up. Water will become increasingly precious. Plants under drought stress grow slower and may not survive. Droughts can lead to significant crop yield losses for farmers.

Possible Solution

Scientists have developed a plant variety that carries a gene from the soil bacterium *Bacillus subtilis*. This gene makes a protein that helps reduce the damaging effects of drought by enabling the plant to preserve normal growth functions even when water is limited.

Cotton Problem

Cotton is one of the most important crops grown in the United States. The major use of the cotton fiber is in the textile industry. The oil from the seeds is used in cooking and in making soaps. The seeds may also be used as food for livestock.



The cotton bollworm is an insect larva that feeds on parts of the cotton plant. Major harvest damage from bollworm infestations results in huge losses to farmers as well as industry, and leads to waste of precious resources like soil, water, and labor.

Possible Solution

To make plants resistant to damage by insect pests, scientists have taken genes from the bacteria *Bacillus thuringiensis* (Bt) and inserted these into the plant. The genes make proteins that are toxic to the insect pests that eat the plants. Bt toxins are desirable pest control agents because they are non-toxic to humans, animals, or most other insects, but are highly effective against specific groups of pest insects. When ingested, Bt toxins act as gut poisons for the pest, causing susceptible insects to stop feeding and eventually die.

Papaya Problem

The papaya is a tropical fruit with a pear shape, sweet taste, and soft texture.



One of the problems with growing papaya is susceptibility to a disease called the papaya ring spot virus. This virus deforms the fruit of young plants and can also prevent the plant from producing fruit. The virus is spread by insects and cannot be contained. Papaya production in Hawaii was cut in half because of this virus.

Possible Solution

Scientists have transferred a gene from the plant virus into plants. This acts like a vaccine that makes the plant resistant to that specific virus. The virus genes are not transferred to humans through the food.

Potato Problem 1

The potato is the leading vegetable crop in the United States. Potatoes are sold fresh and as processed products such as French fries and chips. Raw by-products of potato processing, as well as some potato protein, are used as food for farm animals.



Potatoes can be bruised by impact during harvesting and storage, which results in black spots in the potato. Consumers will not purchase discolored potatoes and those are thrown away. This results in food waste.

Possible Solution

Researchers have discovered that by inserting a piece of a certain wild plant gene, they can turn off the expression of the enzyme in a plant involved in bruising. This prevents discoloration from bruising.

Potato Problem 2

The potato is the leading vegetable crop in the United States. Potatoes are sold fresh and as processed products such as French fries and chips. Raw by-products of potato processing, as well as some potato protein, are used as food for farm animals.



During storage, the starch in the potato can turn into sugar and can negatively affect the color and taste of fried potato products. If sugar formation during storage could be prevented, the French fries and chips made from the stored potato would have a more consistent golden color and a better taste and texture.

Possible Solution

Researchers have discovered that by inserting pieces of certain genes from a plant, they can turn off expression of the enzymes that change starch into sugars. This prevents production of the sugars responsible for undesirable color and taste.

Potato Problem 3

The potato is the leading vegetable crop in the United States. Potatoes are sold fresh and as processed products such as French fries and chips. Raw by-products of potato processing, as well as some potato protein, are used as food for farm animals.



Asparagine is a chemical found in potatoes that causes the potato, when cooked at high temperatures, to produce another chemical called acrylamide. Reducing acrylamide levels in foods may mitigate potential human health risks from exposure to acrylamide. If the amount of asparagine in the potato is reduced, then the amount of acrylamide produced can be reduced.

Possible Solution

Researchers have discovered that by inserting a piece of a certain plant gene, they can turn off expression of the enzyme in plants that makes asparagine and prevent asparagine production.

Potato Problem 4

The potato is the leading vegetable crop in the United States. Potatoes are sold fresh and as processed products such as French fries and chips. Raw by-products of potato processing, as well as some potato protein, are used as food for farm animals.



Late blight, also called potato blight, is the disease that caused the Irish potato famine in the 1840's. This disease rotted the entire potato crop and led to the death of about a million people in Ireland. Late blight disease is still a major problem for potato farmers, especially in regions that receive a great deal of rainfall. Fungicides have been used for decades to prevent the blight disease, which is caused by a fungus-like organism.

Possible Solution

Scientists have developed crops that are resistant to certain fungal diseases by inserting a gene from a wild relative that is resistant to the disease. This acts like a vaccine that makes the crop plant resistant to that specific disease. This new genetically engineered crop is more resistant to the damage caused by the fungus-like organism, so the farmer doesn't need to apply as much fungicide to keep the plants healthy.

Potato Problem 5

The potato is the leading vegetable crop in the United States. Potatoes are sold fresh and as processed products such as French fries and chips. Raw by-products of potato processing, as well as some potato protein, are used as food for farm animals.



Colorado potato beetle larvae are slug-like animals with a soft shell. Larvae eat foliage as they grow; this is the most destructive stage, but the adult beetle can also eat the plant foliage and destroy the potato plant. Methods used to try to control this insect include: crop rotation, beneficial insects, systemic insecticides, foliar insecticides, and Bt products.

Possible Solution

To make plants resistant to damage by insect pests, scientists have taken genes from the bacteria *Bacillus thuringiensis* (Bt) and inserted these into the plant. The genes make proteins that are toxic to the insect pests that eat the plants. Bt toxins are desirable pest control agents because they are non-toxic to humans, animals, or most other insects, but are highly effective against specific groups of pest insects. When ingested, Bt toxins act as gut poisons for the pest, causing susceptible insects to stop feeding and eventually die.

Rice Problem

Rice is grown in more than 100 countries around the world. It is consumed as a staple food in several south and southeast Asian countries where many people suffer from a lack of vitamin A in their diets. Vitamin A deficiency is the leading cause of preventable blindness in children and long-term vitamin A deficiency increases the risk of infections and death. Although the carbohydrates in rice make it a good source of energy, rice has very little vitamin A. Since the populations that are vitamin A deficient are the same ones that use rice as a staple food, improving the nutritional quality of rice could improve their health.



Possible Solution

Scientists inserted two genes – one from a plant and one from bacteria – into a plant to enable it to produce beta-carotene in the crop grains. The grain is 'golden' in color and can be eaten as a source of dietary beta-carotene. The human body can convert the beta-carotene we eat into vitamin A. This grain with beta-carotene has the potential to improve the health of populations that do not currently get enough vitamin A or beta-carotene in their diet.

Soybean Problem 1

Soybeans are protein-rich, edible legumes that are used mainly as livestock food, but they are also used to produce many food ingredients such as tofu, soy beverages, soybean oil, and soy lecithin, which is used in chocolate and ice cream for a smoother texture. Weed growth alongside the crop is a recurring problem for farmers, who use a lot of time and materials to control the weeds.



Possible Solution

Removing weeds by physical methods such as tilling can be time-consuming and expensive, so farmers often spray herbicides to destroy weeds. Farmers use less fuel because fewer passes are made through the field to till. However, a farmer can only spray herbicides on a crop if it is tolerant to the herbicide. Scientists have genetically engineered crop plants to be tolerant to certain herbicides. Use of herbicide-tolerant crops could help reduce environmental damage because the crops require less tilling. Less tilling can lead to reduced soil erosion.

Soybean Problem 2

Soybeans are protein-rich, edible legumes that are used mainly as livestock food, but they are also used to produce many food ingredients such as soybean oil. Soybean oil contains a type of fat – polyunsaturated fat – which makes the oil less stable, resulting in a disagreeable taste and a shorter shelf-life. To increase soybean oil stability, manufacturers use a process called hydrogenation to decrease the levels of the unstable fats. Partial hydrogenation of soybean oil makes the oil more stable when used in food, but the process also produces *trans* fat. *Trans* fat has been linked to heart disease.



Possible Solution

Scientists can use genome editing to remove, or delete, genes in the plant that are involved in the production of the polyunsaturated fat. Instead of making polyunsaturated fat, these plants accumulate more of a monounsaturated fat called oleic acid. Oils with a higher level of oleic acid are more stable, require less processing, and may be useful as an alternative for unhealthy *trans* fat-containing oils in processed food.

Sugar Beet Problem

The sugar beet is a plant that is grown for its sugar content. Part of the plant is also used for animal food.

Sugar beets are labor-intensive to grow and require constant care. Sugar beet farmers consider weeds to be their major problem, and they spend a lot of time, effort, and resources trying to control the weeds. Because sugar beets grow over two seasons, there are many different weeds that affect the crop, so farmers must plan carefully, deciding which weeds to treat and when.



Possible Solution

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Summer Squash Problem

Summer squash is a very common vegetable that is subject to infection from four different viruses. Infections result in stunted, discolored plants and some plants may have spots and an irregular shape. While these vegetables are safe to eat, their appearance deters consumers from purchasing them. The viruses routinely reduce crop yields by 20–80%, depending on the production season and growing region. Farmers use large amounts of insecticides to control the spread of the viruses because insects carry the viruses from plant to plant.



Possible Solution

Scientists have transferred genes from the plant virus into plants. This acts like a vaccine that makes the plant resistant to that specific virus. If the plants are resistant to viral infection, the plants will be healthier and the farmer might use less insecticide to control the insects that spread the virus. The virus genes are not transferred to humans through the food.