Multiple approaches necessary to tackle world's food problems

February 18 2011

Researchers need to use all available resources in an integrated approach to put agriculture on a path to solve the world's food problems while reducing pollution, according to a Penn State biologist. Changes in national and international regulations will be necessary to achieve this goal.

"Using resources more efficiently is what it will take to put agriculture on a path to feed the expected future population of nine billion people," said Nina Fedoroff, Evan Pugh Professor of Biology and Willaman Professor of Life Sciences, Penn State. "We especially need to do a better job using the nutrients, water and energy needed to produce food."

Integrating various sectors of agriculture is one way to conserve and recycle resources. Using wastewater from freshwater aquiculture or fish ponds to irrigate and fertilize fruit and vegetables in a green house and returning the cleaner water to the pond keeps the excess nutrients out of the groundwater, cleans the pond and provides plants nutrients.

"We should ask how we can grow food with a minimum of water, maximum of renewable energy and closest to where people are living," Fedoroff told attendees at the annual meeting of the American Association for the Advancement of Science today (Feb 18) in Washington, D.C.

"We need to expand our ability to farm on land not considered farmable because it is eroded or desertified, using water not considered suitable

for farming because it is wastewater or saltwater," she said. "We need to adapt current crops to higher temperatures and less water and we need to domesticate plants that have evolved to grow at high temperatures and in salty soils."

Some of the land currently considered useless has high soil salt content. Many plants already live in these areas, but few are domesticated. Various wild types of *Salicornia* -- a plant that grows on beaches and in salt marshes -- are currently in use. One type of Salicornia popular in Europe -- known as sea asparagus or sea bean -- is eaten as a vegetable and its seeds contain about 30 percent edible oil -- more than soy beans. Salt marsh sheep, prized in France and gaining popularity in England, graze in coastal areas where salt-tolerant plants thrive. In Australia, saltbush mutton comes from sheep grazed on saltbush -- *Atriplex*. However, salt-tolerant plants have not been domesticated.

From a human viewpoint, seeds are perhaps the most valuable plant parts, but many wild plants have seeds that, once ripe, fall from the plant. This works well for the wild plants but makes harvesting the seeds for replanting or consumption difficult.

"One of the first things in domestication is that plants are chosen that retain their seeds and do not experience seed shatter," said Fedoroff. "As a result of decades of genetic and genomic analysis, we gave a good idea of the genetic changes involved in domestication."

Fedoroff suggests genetically modifying salt-tolerant plants to provide crops to grow in areas that are currently unused or underused. However, the expense of complying with government regulations applied to genetically modified organisms (GMOs) restricts development of plants to large companies producing commodity crops like cotton, corn, soy and canola.

"Everything is reviewed on a case by case basis and it takes years and millions of dollars to get a single GMO out to farmers," said Fedoroff. "The expense of complying with the regulations has virtually eliminated the academic and public sectors from developing specialty crops, like fruits and vegetables, for farmers and right now, the pipeline for producing of such crops is empty."

In the U.S., the EPA regulates insect resistant GMOs with the same laws that they regulate fungicides and rodenticides. The regulations have not changed since 1986, even though insect resistant GMO crops have decreased the use of insecticides almost 10 percent worldwide. Also, genetically modified corn has lower levels of fungal toxins than conventional corn because it is resistant to boring insects that make holes through which fungi can enter the plant.

"The most heartbreaking case is that of Golden Rice, which has been ready for 10 years, but is held up by the years of testing required by the regulations in many countries," said Fedoroff.

Genetically modified Golden Rice produces beta carotene, the naturally occurring precursor to vitamin A. Vitamin A deficiency is a problem in many underdeveloped countries and causes blindness and increased susceptibility to infections. Rice is the most important staple food for large portions of the underdeveloped world.

"Evidence is growing that not only are there not any deleterious effects from insect-resistant and herbicide-tolerant GM plants, but that they are better for the environment because of decreased use of insecticides and less plowing," said Fedoroff.

A 2010 report recently published by the European Union on GMO safety research over the past 10 years concluded that GMO crops are not different from crops modified by other techniques. Yet GMO crops are

the only ones regulated by governments.

"Meeting the food needs of a still-growing human and domestic animal population with less water while preserving remaining biodiversity is, arguably, the most profound challenge of the 21st century," said Fedoroff. "And yet, in the face of overwhelming evidence of positive economic, agronomic and ecological impacts and the absence of detrimental impacts, people in many countries remain adamantly opposed to genetically modified organisms.

Provided by Pennsylvania State University