Vitenskapskomiteen for mattrygghet
Norwegian Scientific Committee for Food Safety

# Mandate

# Residues of plant protection products in herbicide tolerant crops

The adoption of genetically modified (GM) crops worldwide has been rapid since the first transgenic plants were introduced in the USA in 1994. In 2016, the 21st year of commercialization of biotech crops, 185.1 million hectares of biotech crops were planted by ~18 million farmers in 26 countries. (ISAAA , 2016).

Most of the present GM crop acreage is maize, soybean, cotton and rapeseed. Herbicide tolerance traits, increasingly stacked with insect resistance traits, have been continually predominant over the last two decades. In 2015, approximately 85% of the total area devoted to these crops was planted with herbicide tolerant (HT) crops, virtually all being glyphosate-tolerant.

Glyphosate based herbicides kill plants by blocking the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), an enzyme vital to the biosynthesis of aromatic amino acids. There are several ways by which crops can be modified to be glyphosate-tolerant. One strategy is to incorporate a soil bacterium gene that produces a glyphosate tolerant form of EPSPS. Another way is to incorporate a different soil bacterium gene that produces a glyphosate detoxifying enzyme. Other methods by which crops are genetically modified to survive exposure to herbicides include production of physical or physiological barriers, preventing the entry of the herbicide into the plant. The first two approaches are the most common ways scientists develop herbicide tolerant crops.

Other examples on broad-spectrum herbicides used in conjunction with GM crops are dicamba and glufosinate-ammonium. Dicamba resembles the plant hormone auxin and accelerates growth of the plants until eventually killing them. Glufosinate-ammonium kills plants by inhibiting the enzyme glutamine synthetase, vital to plant nitrogen metabolism and detoxifying ammonia. To counter development of weed resistance, HT crops are systematically crossed to tolerate more than one broad-spectrum herbicide, e.g. dicamba and glyphosate, often along with insect resistance traits.

Cultivation of HT crops together with complementary use of broad-spectrum herbicides has significant impacts on crop management strategies and agricultural practices. HT crops permits the use of broad-spectrum herbicides, as an in-crop selective herbicide to control a wide range of broadleaf and grass weeds without sustaining crop injury. This weed management strategy enables post-emergence spraying of established weeds, and gives growers more flexibility to choose spraying times, in comparison with the pre-emergence treatments of conventional crops. HT crops also facilitate low or no tillage cultural practices, and thereby reduce soil erosion.

The broad-spectrum herbicide(s) that are used with HT crops are sprayed directly on the plant canopy. Also, the spraying often takes place later in the growing season than is the case with the selective herbicides that are associated with conventional crops. Levels of herbicide residues and their metabolites may therefore potentially be higher in plants with tolerance to herbicides, compared to that of plants produced by conventional farming practices.

The maximum residue levels (MRL) are the same for GM as for non-GM crops. However, data on residue levels of herbicides and pesticides, including their metabolites, in GM foods are often lacking in the documentation provided by the applicants when seeking authorisation of their GM products (this information is not mandatory).

The Norwegian Scientific Committee for Food Safety (VKM) has repeatedly reported information on residue levels of target herbicides, and metabolites, as a data gap in our risk assessments of food and feed from HT GM-crops. VKM has pointed out that more research is needed to elucidate whether the genetic modifications used to make a plant tolerant against certain herbicide(s) may influence the residue levels or metabolism of the herbicide in question or of other plant protection products. Moreover, whether possible changes in the spectrum of metabolites may result in altered toxicological properties.

At present, these questions fall outside the remit of the Norwegian Scientific Committee for Food Safety (VKM). Thus, VKM considers it necessary to obtain a summary of the status of knowledge on these matters.

Although there are several types of HT-crops, some tolerant to multiple herbicides, the current project will mainly focus on HT-crops tolerant to glyphosate, the active ingredient of the world's most common herbicide - Roundup.

### *Terms of reference*

There is a need for clarification on whether or not the use of plant protection products with herbicide tolerant (HT) crops represent an increased health risk to consumers compared to crops grown under conventional agricultural practices. Increased health risk can occur due to increased levels of herbicide residues and/or their metabolites in food and feed.

In addition, the genetic modifications used to make a plant tolerant against certain herbicide(s) may influence the metabolism of the intended herbicide, as well as the metabolism of other plant protection products. It therefore needs to be clarified in what cases, if any, such changes in the nature and/or magnitude of residues are likely to occur.

In case any novel metabolites are formed in HT-crops, there may also be a need for clarification of their potential toxicity.

The scientific assessment should cover:

- A comparison between common weed control practices used with glyphosate tolerant crops and those used with conventional crops

- Data on residue levels of glyphosate and its metabolites, as well as other relevant herbicides used on conventional crops, in glyphosate tolerant crops and conventional crops

- A description of how the genetic modification(s) used to make a plant tolerant against glyphosate may influence the metabolism of glyphosate or other plant protection products

- An evaluation of whether possible changes in the spectrum of metabolites may have implications for the toxicity of glyphosate tolerant crops