Introduction
Throughout Europe there is an on-going process on implementation of important EU regulations that have put reduction of pollution from agriculture higher on the agenda (i.e. the Water Framework Directive (EC, 2000); the Framework Directive for Sustainable Use of Pesticides (EC, 2009)). At the same time there is an increasing focus on food security and intensification of agricultural production globally. There is a need for increased adoption of sustainable production systems, but also to evaluate what this constitutes taking into account potentially conflicting environmental and economic concerns. In Norway, national cereal production is of large importance for food security (LMD, 2011). There are around 13,500 cereal farms in Norway, cereal crops cover 30% of the farmland, and more than 90% of the cereal area is sprayed annually (Aarstad & Bjørlo, 2012). Cereal production in Norway contributes with 30-72% of the total environmental risk caused by pesticide use in cropping (Refsgaard et al., 2006). Implementation of measures to mitigate pollution from agriculture in these areas will have a larger potential environmental effect than in crops covering smaller areas. Further, the conflicts between measures for reduced use of pesticides and measures for reduced phosphorus (P) losses have special concern in cereal production. Hence, there is a need to investigate how to reduce the pollution caused by soil, phosphorus and pesticides with integrated measures and instruments for implementation.

This is the aim of a three-year research project started spring 2013, with activities focused on (i) optimizing plant protection practices (e.g. soil tillage, forecast systems, precision spraying, risk maps), (ii) monitoring, modelling, understanding and reducing the risk of pesticides, phosphorus and soil loss on field and catchment scale, (iii) understanding and modelling farmer behaviour, (iv) assessing the potentially conflicting concerns from reducing soil erosion, nutrient loss, and pesticide pollution, and optimizing farm economy, and (v) developing instruments for increased adoption of desirable ('best') management practices.

Material and methods
An agricultural catchment dominated by cereal production will be a common research arena for the different work packages (Figure 1). Through a monitoring program started in 1992 (The Norwegian Agricultural Environmental Monitoring Program (JOVA)) a database with long term data for nutrient runoff, soil erosion, pesticide loss and agricultural management practices (fertilization, use of pesticides, soil tillage, yield etc.) has been established for the catchment. These data together with data to be gathered in the project will constitute a base from which measures and instruments to increase the use of sustainable cereal production systems can be developed. A set of production methods in cereal, encompassing a selection of possible pest management measures (e.g. soil tillage, forecast systems, precision spraying, risk maps), will be defined and form the basis of model simulation and evaluation procedures.
The project will be performed through six integrated work packages (WPs). WP1 focuses on developing ‘best plant protection strategies’ for cereal fields in the study area, based on field inventories (manual and sensor based) of weeds and diseases, available forecast systems, and pesticide risk maps. Field studies will proceed through the growing seasons of 2013 and 2014. These results will be coupled to catchment and field scale monitoring (pesticide, phosphorus and soil loss) and modelling exercises (i.e. PRZM, SYNOPS, SWAT) in WPs 2 and 3. Further, these results will be coupled to modelling of farm economy and adaptation (WP4), development of a multi-criteria (MCA) framework for visualizing the performance of different sound production practices on indicators for pollution with pesticides (including environmental risk indicators), phosphorus, yields, farm income and economic risk (WP5), and the development of instruments for increased adoption of environmentally sound crop production methods (WP6).

**Partners**

The different work packages are headed by researchers at the Norwegian Institute for Agricultural and Environmental Research and the Norwegian Agricultural Economics Research Institute, and accomplished in collaboration with the Norwegian Forest and Landscape institute, the Swedish Agricultural University, the University of Copenhagen, Thünen Institute for Regional Development, and the Julius Kühn Institute. The development of an MCA framework will involve the collaboration with relevant institutions carrying out the instruments (i.e. the Agricultural Authority, Extension Service, County Governors and the Food Safety Authority).

**References**


