

# Improving nutrient use efficiency in major European food, feed and biofuel crops to reduce the negative environmental impact of crop production (Project NUE-crops)



***The intensification of primary food production over the last 40 years has resulted in an increasingly reliance of food production on non-renewable resources including (a) energy, (b) mineral fertilisers and (c) fossil water sources. While this has resulted in an increase in yields per unit area, there has been a significant reduction in resource use efficiency and self sufficiency at the farm, regional and individual country level.***

## **Background**

It has been estimated that the doubling of global food production over the last 40 years has been associated with a 5-7 fold increase in mineral (N, P, K) fertiliser use. This means that mineral nutrient use efficiency (NUE) of crop production decreased 2-3 fold during this period, while energy use and greenhouse gas emissions (e.g. those associated with N-fertiliser manufacture) and environmental pollution from nitrate-leaching and phosphorus run-off increased significantly. Also, known deposits of phosphorus fertiliser are estimated to be depleted within 60 to 100 years at current consumption levels, but consumption is likely to further increase in the future.

To improve the sustainability of primary food production at a time when the world population is predicted to rise from 6 to 9 Billion over the next 30 years will therefore require an integration of technologies/strategies focused on: (a) reducing loss/waste of resources (e.g. by minimising NPK-leaching and/or run-off, soil erosion and salinity, and/or evapo-transpiration and/or irrigation related water losses), (b) improved recycling of resources (e.g. recycling of mineral nutrients via green and animal manures and appropriately processed domestic/communal organic wastes; domestic waste water recycling into agriculture) and (c) plant breeding (including molecular assisted selection) for appropriate combinations of resource use efficiency and biotic/abiotic stress resistance, productivity and food quality and safety traits.

## **Objectives**

The overall objective of the NUE-crops project is to develop knowledge, models and tools required to (a) breed/select nutrient (and water) use efficient crops and (b) integrate the use of such crops with agronomic innovations to significantly reduce fertiliser (and water) use and associated negative environmental impacts of crop production, while maintaining or improving crop yield and quality.



## Results

The project is currently in its first year. To achieve the overall aim NUE-crops will develop knowledge, models and tools required to:

### **1. breed crops with increased for nutrient use efficiency (NUE) this will involve use of:**

- classical QTL identification approaches based on simultaneous phenotyping and genotyping of populations developed from parents with contrasting NUE traits,
- association genetics approaches which allow phenotypic characters and molecular marker data from unrelated lines and varieties to be linked,
- gene expression profiling (and where appropriate proteomic and metabolomic analyses) of genotypes with high and low NUE exposed to contrasting fertilisation regimes and
- whole plant physiological studies.

**2. improve agricultural practices to optimise the performance** of nutrient use efficient crop varieties with respect to reducing fertiliser use and associated negative environmental impacts, while maintaining or improving crop yields and quality. This will involve:

- detailed assessment of crop genotypes with distinct levels and/or mechanisms of NUE within the context of different rotational, fertilisation and/or production system scenarios using established long-term, factorial field experiments, and
- the construction and validation of models/algorithms for nutrient budgeting and precision farming systems that consider varietal differences in “*nutrient uptake and acquisition, storage and utilisation of fertilisers*” when calculating fertiliser recommendations for commercial crop production systems.

## Impact

The concepts for maximising the impact with respect to the overall aim (see above) are to:

- utilise and transfer knowledge obtained with model systems (*Arabidopsis*, barley) to widely grown crops associated with extensive N and P fertiliser inputs and environmental losses,
- target 4 major crop species (wheat, oilseed rape, potato and maize) that together account for >50% of mineral fertiliser inputs and associated environmental impacts in Europe,
- include 3 large European breeding companies as partners; they will (a) provide extensive background IP, materials and facilities, and (b) cover >2.3M € of project costs,
- include partners from the PR-China (ICPC) and USA, which together with Europe account for >60% of global mineral fertiliser use, in R&D, training and dissemination activities,
- provide a strong dissemination and training programme to facilitate rapid technology transfer and introduction of innovations from the project into commercial practice.

**For more information, please visit the website: <http://research.ncl.ac.uk/nefg/nuecrops>**

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**EC contribution: 6.000,000 €**

**Duration: 60 months**

**Starting date: 01/05/2009**

**Partners:** Newcastle University (UK), Wageningen University and Research Centre (NL), University of Göttingen (DE), AgroBio Institute (BG), University of Aarhus (DK), Research Institute for Organic Farming (CH), Scottish Crop Research Institute (UK), University of Düsseldorf (DE), Chinese Academy of Agricultural Science (CN), Washington State University (US), KWS Saat AG (DE), KWS-UK (UK), Agrico (NL), Sabanci University (TK)