EU-Rotate_N

European Community network to develop a model based decision support system to optimise nitrogen use in horticultural crop rotations across Europe

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Welcome

EU-Rotate_N is a four year project, funded by the European Commission within the Fifth Framework Programme, and is co-ordinated by Dr Clive Rahn at Warwick HRI. The project started in January 2003 and built on work completed by a previous European project, ENVEG. This, the fourth and last newsletter reports on the progress of the EU-Rotate_N project during 2006. More detail, news and the new model can be found at www.warwick.ac.uk/go/eurotaten.

Aims and Objectives

Most vegetables within Europe are produced in intensive rotations, which rely heavily on large inputs of nitrogen from fertilizer or organic sources to maintain the yield and quality of produce. Unfortunately, many field vegetable crops use nitrogen inefficiently and often leave large amounts of nitrogen (either as unused fertilizer or crop debris) in the soil after harvest. This potentially causes pollution to soil, water and aerial environments. Recent research has shown that the environmental impact can be reduced without loss of yield or quality by improving the design of rotations and by more closely matching nitrogen supply to the demands of individual crops. The main project deliverable is a decision support system (the model) that can be used to compare the effects of different crop sequences, fertilizer rates and other management practices on the cycling of nitrogen within rotations, for widely different production systems and climatic conditions across Europe.

Introduction to the new model and its future use

EU-Rotate_N is a new computer model developed over the last four years by a consortium of European researchers. It is a decision support system for soil-plant interactions based on the use of nitrogen in crop rotations. However, additional features allow analysis and comparison of environmental and economic considerations which will extend the use of its results beyond farmers and growers to consultants and policymakers. The model is written in FORTRAN and runs through Microsoft's DOS emulator. Inputs into the model are via text files and outputs take the same format. The model allows the experienced researcher great flexibility since all inputs can be modified to suit local conditions, equally default values for all the main inputs allows the casual user to overview the model's abilities. The model, complete with instructions and example files is available on the project website at www.warwick.ac.uk/go/eurotaten.

Help! Despite extensive testing it is inevitable that some problems and bugs exist. There will also be opportunities to develop the capability of the model further. In either case, we would like to hear from you.

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Testing management strategies for nitrogen and crop rotations.

Development of the model has allowed the testing of a wide range of strategies on potential gross margin and nitrogen losses. Work within the project has confirmed that the risk of nitrogen losses is indeed very high, particularly on the lightest soils best suited to the management of vegetable crops. The benefit from adopting current good agricultural practice (GAP) is varied with some areas benefiting both in terms of leaching losses and gross margin.

In other areas, especially on light soils, following GAP can lead to a reduction in gross margins with only marginal differences in N losses by leaching. The use of the model points to potential for improvements if rotations are designed more effectively utilising the ability of deep rooted crops to take up N left behind by previous crop. Three examples are included in this newsletter of the simulated effects of different practices in Italy, Spain and Norway. More examples are available at the website.

The economics of different vegetable rotations and nitrogen fertilizer rates in Italy – Accursio Venezia and Fillipo Piro

In a Mediterranean environment, the Campania region in Italy, a two year rotation (autumn-spring-autumn-spring) containing the same four vegetables (cabbage, fennel, lettuce, spinach) was simulated under three different nitrogen fertilizer strategies: typical farmer's (F), good agricultural practices (GAP) and a control where no nitrogen was applied. Simulations were performed on two soil types: a loam with 43% sand, 18% clay and 3.5% organic matter and a clay with 30% sand, 40% clay and 0.8% organic matter. All simulations were run using the same observed weather. The results showed that the recommended nitrogen inputs for GAP were 50% less than the farmer's rates for lettuce and 6% less for fennel. In the second cycle (see figure opposite) there were considerable effects of crop sequence, soil type and nitrogen input schemes on both financial returns and nitrogen leaching. Adhering to GAP did not provide any significant environmental benefits but did reduce gross margins. However, rotations can be designed (see lower panels) which provide greater financial returns using farmers practices compared to GAP with some reduction in N leaching. Influences of GAP are different on different soil types – on lighter soil leaching is reduced where N is applied as ammonium N but the amount of N lost to air increases!

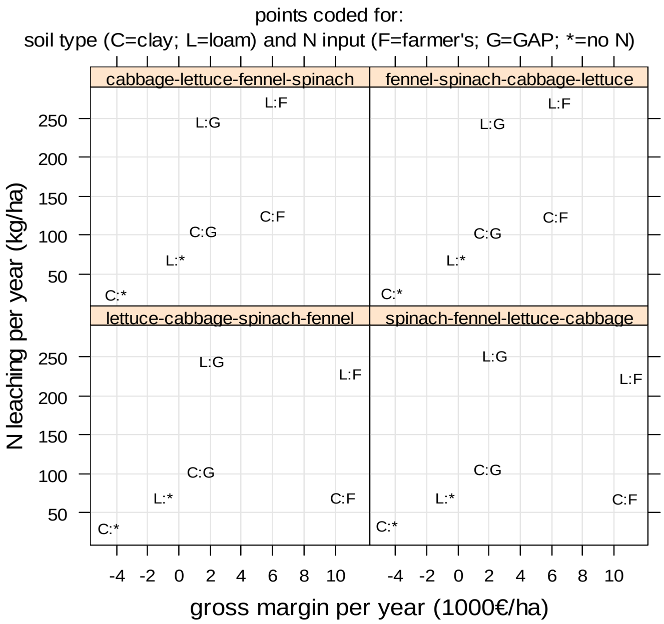

Figure. Relationship between N leaching and gross margin for a four crop rotation.

The use of scenarios in Norway – Hugh Riley

Vegetables are grown in the east, south and south-west of Norway under different climatic conditions. The east has cold winters and a short, dry growing season while it is milder and wetter in the south and southwest. Soil types vary, with loams in the east and sandy loams or sands in other regions. Early vegetable crops are grown mostly in the regions south of Oslo, often in short rotations due to limited land availability.

Scenarios represent crops with contrasting nitrogen requirements. For the eastern region, rotations with up to 50% vegetables were selected. Simulations showed that annual leaching from a cereal-potato rotation was about 35 kg/ha; including cabbage or onions in the rotation increased this by about 25%, whilst inclusion of Swedes reduced it. Carrots were also found to give low leaching. Growing both cabbage and onion gave >50% more leaching and the inclusion of cauliflower as well almost doubled it.

The new EU-Rotate_N model, complete with instructions and example files can be downloaded from the project website at www.warwick.ac.uk/go/eurotaten

In the south, simulations suggested that despite lower soil organic matter, annual leaching was 10-20% higher compared to the inland region. Early-season crops required smaller amounts of nitrogen fertilizer but leached the same amount of nitrogen as main-season crops. The inclusion of peas instead of one of the other vegetables reduced leaching.

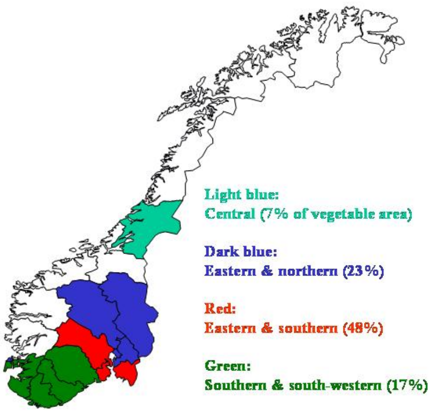

Figure. Vegetable growing regions in Norway.

More intensive vegetable rotations, with vegetables in 4 out of 6 years, gave higher amounts of leaching both in the eastern region and in southerly regions. Leaching was about 40% lower in the eastern region than further south, due to the milder, wetter climate in the latter regions. About 5-10% more leaching was simulated from a sandy soil than from a sandy loam in all regions.

The simulations suggest that farmers gain little in terms of gross margins by using higher than the recommended nitrogen fertilizer rates in the east. However, in the south, recommended rates may be too low. This is reflected by the fact that local advisers are known to recommend higher fertilizer rates. These findings confirm the need for alternative practices, such as the use of slow-release N fertilizer, which is currently receiving attention in southern Norway. The use of autumn-sown, deep-rooting catch crops is another alternative that should be considered in these regions.

In inland regions, the use of catch crops is limited by the time available for crop establishment and the high risk of frost kill. Here, cropping sequence is an important factor for optimising nitrogen uptake by crops. Simulations suggest that the growing of Swedes or carrots after cabbage or cauliflower can reduce nitrogen leaching and that it takes a relatively long time before leaching occurs under the relatively dry inland conditions.

The simulations clearly show the differences in the amount of nitrogen lost through leaching between regions with different climate, between soils with contrasting moisture retention and between rotational types. In practice, however, the location and type of cropping is determined more by crop requirements in terms of climate suitability and by economic factors such as proximity to processing industry rather than by environmental considerations. It is an unfortunate but largely unavoidable fact that vegetable production in Norway is located in areas with a high risk of leaching.

The use of scenarios in Spain – Jordi Doltra and Carlos Ramos

The effects of N fertilization based on traditional farmer practices (F), and on the Valencian Good Agricultural Practices Code (GAP) on rotation productivity and N losses, were compared using a model farm concept. Model farms were defined in terms of crops grown, type of soil, irrigation practices and climatic conditions and represented about 90% of the vegetable production in the area (29,000 ha). The GAP Valencian code establishes the crop N requirement and from this subtracts mineral N at planting and the N applied in irrigation water. The results show that adopting GAP could reduce inputs of fertilizer N by 10-50% with minimum impact on the farm gross margin. This scenario has important environmental benefits: a 40-60% decrease in the NO_3-N leached to groundwater and a 10-50% reduction in the N loss by volatilization could be achieved (see table overleaf).

Adopting GAP would result in significant cost savings by reducing the amounts of mineral N fertilizers applied, with almost no impact on yield and gross margin. The implementation of GAP provides an assurance of quality which buyers and customers demand these days in addition to providing an economic premium for farmers. In summary, reductions in nitrogen fertilizer, as well as being environmentally friendly, could also increase farmers income.

The enforcement of GAP at policy level could also bring rewards. Concerns over nitrate levels in vegetables and eutrophication caused by nutrient leaching should force policy makers in Spain to demand that GAP is adopted by all farmers and cooperatives. Restrictions on fertilizer use and increased traceability will bring benefits to not just the environment but also growers and purchasers of vegetables. To support this approach, it is important that fertiliser recommendations are formulated for all crops and that recommendations are underwritten by research.

The results also show the importance of efficient irrigation which should encourage the change from traditional irrigation systems (furrow and surface) to drip irrigation systems. Since water availability is of increasing concern, policies encouraging and promoting the adoption of advanced irrigation technology are of great importance.

Crop rotation 1	F	GAP	Units	Difference %
Inorganic N fertilizer	277	252	kg N/ha	-9.0
N irrigation	54	46	kg N/ha	-14.7
N mineralised	152	151	kg N/ha	-0.4
N uptake	333	337	kg N/ha	+1
N leached (90cm)	85	51	kg N/ha	-39.4
N Gaseous loss	102	93	kg N/ha	-8.5
Gross Margin	9967	10133	Eu/ha	+1.7
Crop rotation 2	**F**	**GAP**	**Units**	**Difference %**
Inorganic N-fertilizer	765	350	kg N/ha	-54.2
N irrigation	62	62	kg N/ha	0
N mineralised	309	296	kg N/ha	-4.2
N uptake	467	455	kg N/ha	-2.5
N leached (90cm)	555	235	kg N/ha	-57.7
N Gaseous loss	168	79	kg N/ha	-53.3
Gross Margin	5550	5800	Eu/ha	+4.5

Table. Comparison of the average annual values of N related parameters and gross margin in one drip irrigated (rotation 1) and one furrow irrigated (rotation 2) crop rotation. N levels are for Traditional Farmer Practice (F) and Good Agricultural Practice (GAP). Crop rotation 1 is a three-year rotation starting and finishing in mid-summer which included artichoke, lettuce, broccoli and melon. Crop rotation 2 is a two year rotation starting on the 1st of January and finishing on the 31st of December which included watermelon, cabbage, escarole, pepper, broccoli and watermelon.

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