Focus Group Fertiliser efficiency in horticulture

Mini-paper - Fertiliser planning and simple recommendation systems

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1 Introduction

Fertiliser planning is essential to obtain the best balance of economic and environmental benefits. The information presented to the focus group suggests wide implementation of fertiliser planning systems, but only one of the systems was described in supporting factsheets. The roles of determinations of soil supply of N to inform such planning were less well implemented. The first conclusion of this paper is that these systems should be described, the description have to include the information readily available to the growers. The second is to identify the characteristics of planning systems that achieve higher rates of implementation, say >50% - > 80%.

Technique	Not Implemented	Implemented at <2% of the farms	Implemented at 2-20% of the farms	Implemented at >20% of the farms
Fertilisation planning			WA, SP	FL, NL, SW, PL, IT, DK, DE, HU, UK, IRL, SP, SP, SP, PT,BG
Determine the N need by soil determinations	IRL	SP	WA, SW, IT, DK, UK, SP	NL, PL, FL, DE, FR, HU, PT

The key stumbling blocks identified in the implementation of the techniques were

1. *Fertiliser Planning*

There are lots of tools available at different levels of sophistication. Field specific prediction models tend to be data hungry and require a lot of input by the farmer. Farmers have too many important tasks to fulfil, thus they need simple answers feasible at farm level. Fertiliser planning tools should be devised with the needs of the farmer clearly in mind or they will not be used.

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Fertiliser planning systems may look attractive scientifically but if they involve significant extra labour costs they could fail. Systems that don't provide enough benefits for the farmer particularly of a financial nature can easily fail. There is no benefit from better fertiliser planning systems if fertiliser spreaders are not properly maintained and calibrated. Placed fertiliser can deliver benefits but only if the costs of adapting available machinery are not prohibitive.

Fertiliser planning over crop rotations was indicated as potentially being very successful in reducing pollution but land management - the process of renting fields was thought to be a major limitation. Incentives are required to improve the management of soils in the longer term over crop rotations. Operational groups have been utilised in Flanders to improve the management of rented fields.

2. Soil Min N determination

According to the NUTRIHORT project soil determinations are widely used in some countries. A major uncertainty being N mineralisation which is partly overcome by regular sampling (NExpert and KNS systems). However many countries found that whilst the test might be good in theory it was not in practice. Sampling, especially regular samplings, can be costly. Timing of sampling has to be carefully worked out and cannot be taken too soon after the application of fertilisers or organic manures. Interpretation is also a challenge, and whilst models can help this, they can add another layer of complexity.

This paper will include a brief outline of the process of developing a fertiliser recommendation system for nitrogen with the aim of stimulating discussion of future research and implementation needs. Some examples of fertiliser planning systems will be included in the appendix.

2 Fertiliser Planning systems for Nitrogen

2.1 Key parameters

The system must be widely available, transparent, have a scientific background, and be seen to be reliable delivering best yield and quality. It should not be data hungry or require data not easily obtained. Stakeholders (such as regulators, fertiliser companies, special interest and growers groups) must be fully involved in the development of the system to ensure buy in and to ensure that the systems provide delivery of both environmental (reducing N losses) and economic benefits. Demonstration of the systems on farm scale plots/demonstration farms is seen to be beneficial.

Following the release of the system there needs to be sufficient support to enable uptake and implementation with sufficient lines of communication to provide help in use, correct errors and fill in gaps. Support can be provided by field demonstrations of the technique in use. Fertiliser companies can obviously play a part in this process through their technical and agronomic services (i.e. Fertiberia provides a diagnosis and recommendation tool ("SIDDRA") available for its customers). However not all commercial services are independent. Support of this type is not cheap to provide and is not seen as innovative enough to attract core funding which it needs.

Rahn (2012) discusses the challenges of implementing fertiliser recommendation systems in practice.

A recommendation system for N could be based on three factors:

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1) **Crop N requirement** – for the crop under optimum growing conditions (Taking account of the productivity of the crop.) .

2) **Assessing Soil N supply -** from the soil to rooting depth. – Available and potentially available N from mineralisation of residues and soil organic matter.

3) **Fertiliser N supply** - how much of the fertiliser supplied will be taken up by the crops.

The recommendation for fertiliser application rate is based on the difference between crop nutrient requirement and the nutrient supply from soil to rooting depth. This information can provide the basis of a system which can be extended in complexity to take account of other factors such as cultivar, fertiliser type, delivery system, soil and weather dependant factors.

2.2 Format

Across Europe the number, size and distributions of farmers is different, the delivery system for the fertiliser planning system should match the demographics and structure of the vegetable production sector. Whilst the utilisation of computer based systems might suit the larger farmer, table based systems may suit the smaller farmer. The table format is obviously the most flexible in terms of knowledge transfer, as it can be published in a book, an Ebook, on the web as a table or as part of a simple computer based decision support tool. It can be published alongside its description and validation in an easily accessible form.

The same fertiliser planning tools could underpin the basis of many systems:

1. As a directly published table based system.
2. A simple computer decision support tool such as PLANET might be based on the table based system (Defra 2010).
3. Models such as N_Expert, WELL_N, EU-Rotate_N could be used to generate recommendation tables for wider publication and use.
4. Models in 3 could be utilised directly to provide recommendations in more complex and specific situations.

The basic system could be extendable, i.e. present information on the base dressing and provide tools for finer tuning later. This is essential as there will be seasonal and unforeseen factors such as weather / pests etc that will require N advice to be adjusted / changed during the growing season. Adaption of the application rate is also necessary should fertiliser dressings be split or placed, different types utilised. Such fine tuning would need to be supported by reliable crop/soil monitoring systems i.e. adopt a Prescriptive - Corrective approach.

A well designed system, which helps the farmer to understand the balance between nutrient supply and demand, enables the farmer to make better adjustments for his local field situations, i.e. should his yield expectations be different from those in the recommendation system. The system should also demonstrate the benefits of calibration and maintenance of fertiliser spreading machinery.

Local experience is critical in fine tuning fertiliser advice and a dialogue between the advisor and the farmer is extremely beneficial.

NB – Any fertiliser planning system must be backed up by sound science and be transparent enough to facilitate trust for it to be widely implemented.

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2.3 Crop Nitrogen Requirement

The nutrient content of an optimally fertilised crop at harvest, and its associated marketable fresh weight and dry matter yield, provide key information, as this provides a target for N supply. There are some generic relationships between N content and dry matter yield providing critical N curves to determine minimum plant N concentration for optimum growth (Examples include Greenwood *et al.*, 1989; Tei *et al.*, 2002) which enable data to be pooled over different experiments. Some crops, like leeks, may additionally need higher concentrations of N in order to maintain crop colour, whilst others, like calabrese, may be more sensitive to disease and consequently have a lower critical N. It is suggested that data for other crop properties such as the DM% of marketable produce and harvest index may also be shared for a range of optimally fertilised crops.

Similar information over the whole growing season (plant N levels required at different stages of crop development), linked with information on root growth, would provide targets for earlier nutrient requirement and thus enable more efficient synchronisation of resources. There would be advantages in carrying this out on a regional basis for making decisions at a local level, taking into account the actual growing system and local management.

2.4 Soil Supply of Nitrogen

For adequate growth crops need to be well supplied with nitrogen from the soil and, where these are not enough, supplemented from fertiliser or manures. Demand should be adequately supplemented to ensure soil fertility is maintained. Estimates of soil supply need to take into account the amount of N already in the soil, and that subsequently mineralised from previously incorporated crop residues, manures and native soil organic matter. The importance of soil structure in maximising the impact of N already in the soil needs to be emphasised here. The use of extra N to compensate for poor soil structure is not acceptable.

The determination of available soil mineral N is relatively easy by soil sampling to rooting depth. However the release of N from previously incorporated crop residues or from soil organic matter is never easy to predict. The KNS system does provide a partial solution to the mineralisation problem, bur requires repeated assessment of soil mineral N which would incur considerable costs. The KNS system recommending nitrogen from fertilisers at several times during the season. In some areas vegetables are grown without irrigation so late application of fertiliser would become ineffective.

The person who takes the soil samples has an important job to assess the crop. This gives extra information for the advisor who gives the fertilisation recommendation. (Both information about the crop and the soil is needed to give a good fertiliser recommendation). Ideally, the fertiliser recommendation arises in dialogue between advisor and farmer.

In the UK system the Soil Supply of N can be directly measured or estimated from previous cropping history and rainfall over the previous winter, in tables. There can be considerable uncertainty in the direct measurements of soil mineral N, and such measurements can be difficult to interpret. These challenges and the situations where soil mineral N measurements are advantageous are outlined in a FACTSHEET on assessment of soil mineral N (Rahn, 2012).

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2.5 Fertiliser supply

Fertiliser can be used to make up the difference between what the crop needs and what is supplied from the soil. There are an ever increasing range of options for applying fertiliser. The basic fertiliser planning tool should be able to specify the total amount of fertiliser to be applied and to make suggestions on when it should be applied. For instance on rain fed light soils splitting fertiliser dressings avoids leaching losses. On more retentive soils it might be appropriate to supply all the N in one or two doses. Once the amount of fertiliser is decided, decisions will need to be made on the type of fertiliser to be supplied (ammonia, urea, nitrate or organic). The recommendations assume that all other nutrients and water are in sufficient supply and that crop growth is not limited by pest or disease.

Fertilisers can be targeted. Burns *et al*. (2010) and Salo (2008 unpublished) have indicated the benefits of targeted amounts of fertiliser applied at planting which can raise fertiliser efficiency. However, Rahn *et al*. (1996) have shown that these effects can only be seen if other inputs such as water are adequately supplied. Fertigation also holds promise (Monahan, 2010) and even water supply can increase the availability and use of nutrients throughout the growing period.

The simple systems can be supported by additional information that allow decisions about which form of fertiliser to apply.

2.6 Corrective tools

The most basic fertiliser planning tools will be relatively prescriptive and suit smaller farmers but the larger more sophisticated growers may want to fine tune the basic recommendations to suit their local situation. With time growers will become both more confident and open to using corrective tools for managing nutrients.

Computer models have the ability to be utilised for this purpose as they have the potential to assess the effects of previous history on the starting N supply and enable the option of more closely matching soil supply with crop demand over the whole growing season. Models could be utilised to fine tune recommendations on a regional or site specific basis.

There is an ever increasing range of monitoring techniques, such as foliar analysis, radiation, SPAD, NDVI, DRIS etc that could be utilised to test plant status, as they can indicate an imbalance between supply and demand which may be corrected by additional amounts of fertiliser if the soil is moist enough for it to be available. Farneselli *et al*. (2010) demonstrate such techniques, but a problem is often how best to interpret the results of any of these figures. Any new systems would need good technical support in the early adoption of new techniques required / training of farmers / agronomists to use and understand the system.

No tool is perfect. Many of them are context specific; they can generate large amounts of data. Research needs to be carried out to independently review their strengths and weaknesses – not innovative but a piece of work that requires funding to avoid unnecessary use of spurious technology.

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3 Concluding Remarks

Even with so many diverse crops and sparse data, it is still possible to construct recommendation systems to make more effective use of fertilisers. Such systems can be improved by sharing of information between countries - for example the N concentration and crop size of optimally fertilised crops. More work needs to be carried out to improve and pool this basic information for crops over a range of growth stages.

Tools for assessing the N status of soils and plants are necessary to ensure there is a balance between N supply and N requirement. Pooling of expertise on these tools, especially the interpretation of their results, will help.

Computer models have the potential to integrate research on a range of temporal and spatial scales and to provide simulations of the effects of changing practice on diffuse pollution and productivity.

An ideal recommendation system would need the following to be adopted by farmers:

1. Show financial / environmental benefits of saving on N applications
2. Needs to be easy to understand / implement / no extra work load
3. Needs to be low cost
4. An effective tool for technology transfer is required for example Ireland BETTER farms / discussion groups (theory into practice)
5. Link up with industry partners and train / understand new technology
6. A range of dissemination methods (see Rahn, 2013)
7. Provide technical support / website / iPhone etc.
8. Monitor and fine tune the system to meet crop requirements

NEEDS FOR FUTURE RESEARCH AND DISSEMINATION (Rahn, 2010)

1. Core funding for satisfying **basic technology (not necessarily innovative) is urgently** needed before the experts base disappears.
2. Pooling of data on nutrient uptake of **optimally fertilised crops** such as used in the UK RB209, KNS System, SIDDRA.
3. Use of Models to improve understanding in this area.

4 Acknowledgements

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5 References

Burns, I.G., Hammond, J.P., White, P.J., 2010. Precision Placement of fertiliser for optimising the early nutrition of vegetable crops- A review of the implications for the yield and quality of crops, and their nutrient use efficiency. Acta Horticulturae 852: 27-37.

Defra, 2010. Fertiliser Manual (RB209) 8th Edition HMSO.

Farneselli, M., Benincasa, P., Tei, F., 2010. Validation of N nutritional status tools for processing tomato. Acta Horticulturae 852:227-232.

Greenwood, D.J., Draycott, A., 1989. Experimental validation of an N-response model for widely different crops. Fertiliser Research 18, 153-174.

Monaghan, J., Rahn, C.R., Hilton, H.W., Wood, M., 2010. Improved efficiency of nutrient and water use for high quality field vegetable production using fertigation. Acta Horticulturae 852, 145-152.

Rahn, C.R., Shepherd, M.A., Hiron, R.W.P., 1996. The effect of water supply on the response of onions and calabrese to starter solutions. Acta Horticulturae, No.428, pp 141-150.

Rahn, C., 2010. The future of research into the nutrient requirements of Field Vegetable crops. Acta Horticulturae No 852 335-345.

Rahn, C.R., 2012. Soil Nitrogen Supply for Field Vegetables. HDC Factsheet 09/12.

Rahn, C.R., 2013. The challenges of knowledge transfer in the implementation of the Nitrates Directive. In: D'Haene, K., Vandecasteele, B., De Vis, R., Crappé, S., Callens, D., Mechant, E., Hofman, G., De Neve, S. (Eds.), Nutrihort (Nutrient management, innovative techniques and nutrient legislation in intensive horticulture for an improved water quality) Proceedings, Ghent, pp. 9-15.

Salo, 2008. Unpublished.

Tei, F., Benincasa, P., Guiducci, M., *et al.*, 2002. Critical nitrogen concentration in processing tomato European Journal of Agronomy 18, 45-55.

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Appendices Examples of fertiliser planning systems provided by authors

Appendix 1 UK - RB209 as an example of a fertiliser planning system (Defra, 2010)

Software PLANET based on RB209 www.planet4farmers.co.uk

The Fertiliser recommendations for field vegetable crops in England Wales and Northern Ireland (In RB209), also known as "The Fertiliser Manual". The 8th edition was released in 2010 as a printed book, as an electronic pdf and latterly in a model which together with the rules for N management in Nitrate Vulnerable Zones (NVZ) was released as PLANET. PLANET is a computer based tool providing fertiliser advice and compliance information in one place. RB209 was developed in co-operation with the fertiliser industry, the levy boards, growers representing the main vegetables groups and other key stakeholders.

The N recommendations in RB209 are based on a framework containing

1. The optimum nutrient requirement,
2. An assessments of the nutrient supply and
3. Fertiliser need.

The aim was to bring the recommendations up to date, to take into account increased levels of productivity and to provide transparency for those changes. The process of was hampered by the lack of trials testing N response for the 21 crops for which it provided recommendations. Elements of the data specified above were utilised in a framework to make efficient use of it. The data used in the framework is listed in Table 4.

Crop needs were estimated from the nitrogen content of an optimally fertilised crop, the yield of which was provided by data on optimum yields from field experiments, adjusted by the experiences of an expert panel of horticultural consultants. Field experiments provided data at the optimum N content that was averaged to estimate the appropriate dry matter (DM) percentage of marketable produce and the harvest index. These data allowed a DM yield to be calculated, the N content of which was determined from relationships of critical N against dry matter proposed by (Greenwood, 1989).

The supply of nitrogen from the soil was based on the soil mineral N content at planting, which could be measured or estimated from previous cropping, taking into account winter rainfall and soil type as in the previous version of RB209 (MAFF, 2000). The proportion of this available N was calculated to rooting depth and was based on approximate relationships between yield and rooting depth, with 10 cm of rooting depth for each tonne of DM yield, except in the case of onions and leeks (Greenwood *et al.*,1982). Mineralisation of N from soil organic matter provided further N and was estimated from the length of the growing season based on 0.7 kg ha^{-1} day^{-1} adjusted for temperature (Parton *et al.*, 1987), as in the N_ABLE and WELL_N models (Greenwood, 2001; Rahn *et al.*, 1996). The total of these contributions were assumed to be 100% efficient, as in the previous version of RB209.

From these data, the amounts of N needed from fertiliser could be calculated. Fertiliser efficiency was estimated to be 60%. The final recommendations, an example of which is shown in Table below, provided recommendations for six levels of soil N supply based on soil mineral N to 90 cm depth, measured or estimated just before planting.

This framework has been utilised to **provide recommendations for 21 crops** in the new fertiliser manual. This system provides a vehicle for tailoring recommendations to individual fields, taking into account differences in yield and season. It also illustrates that recommendations can be based on relatively sparse datasets or even data from other countries. New crops can be added relatively easily.

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It also provides a structure into which revisions and improvements can be undertaken. For instance, more discussion with growers could improve the assessments of expected yields and the proportions of crops that are marketable.

Table Example of the framework for the national recommendation system for Lettuce in RB209 in England Wales and Northern Ireland.

CROP NEEDS

Expected Marketable Yield t/ha	46
Dry matter of Marketable crop %	5.3
Proportion of crop grown marketable %	50
Total Dry matter yield Whole Crop t/ha	4.8
Associated nitrogen content	**165 kg/ha N**

SUPPLY

Soil Nitrogen Supply Index (2) kg/ha N to 90 cm	90
Rooting Depth cm	45
Release of N from Soil organic matter	22
TOTAL Supply from Soil to rooting depth	**67 kg/ha N**

FERTILISER REQUIREMENT

Crop Needs – Supply from soil (adjusted for rooting depth) = Fertiliser Requirement

A further adjustment has to be made for fertiliser recovery which is assumed to be 60%

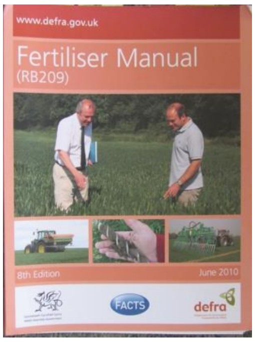
The fertiliser requirement for this crop is then

(165 - 67)/0.6 = 163 kg/N fertiliser required

163 kg/ha N is the Fertiliser Recommendation

Table The new National Fertiliser recommendations for Lettuce

	Soil Nitrogen Supply Index (Soil mineral N level to 90 cm kg/ha)						
	0 (50)	1 (70)	2 (90)	3(110)	4 (140)	5 (200)	6 >250
N kg/ha	200	180	160	150	125	75	30



Book download from

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69469/rb209-fertiliser-manual-110412.pdf

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References

Greenwood, D.J., Gerwitz, A., Stone, D.A., Barnes, A., 1982. Root Development in Vegetable crops. *Plant and Soil* 68, 75-96.

Greenwood, D.J., Draycott, A., 1989. Experimental validation of an N-response model for widely different crops. *Fertiliser Research* 18, 153-174.

Greenwood, D.J., 2001. Modelling N-response of Field Vegetable Crops grown under Diverse Conditions with N_ABLE: A review*. J. Plant Nutr*. 24, 1799-1815.

MAFF, 2000. Fertilizer Recommendations for agricultural and horticultural crops. Reference Book 209 7th Edition. London: HMSO.

Defra, 2010. Fertiliser Manual (RB209) 8th Edition HMSO.

Parton, W.J., Schimel, D.S., Cole, C.V., Ojima, D.S., 1987. Analysis of Factors Controlling Soil Organic Matter Levels in Great Plains Grasslands. *Soil Sci. Soc. Am. J.* 51, 1173-1179.

Rahn, C.R., Greenwood, D.J., Draycott, A., 1996. Prediction of nitrogen fertilizer requirement with HRI WELL_N Computer Model. In: *Progress in Nitrogen Cycling. Proceedings of 8th Nitrogen Fixation Workshop, University of Ghent, 5-8 September 1994.* (Eds O. van Cleemput, G. Hofman & A. Vermoesen) pp 255-258. Dordrecht: Kluwer.

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Appendix 2a SPAIN - SIDDRA Software

Short Description

Fertiberia, a fertiliser supply company, uses the software tool SIDDRA to **generate N recommendations** for grain corn, silage corn, barley, wheat, garlic, onion, oats, rapeseed, sunflower, poppy seed, lettuce, olives, orange trees, pear, peach, and many others crops common in the Mediterranean region. It is available throughout Spain and Portugal (González-Paloma, 2008b, a)

The foliar interpretation systems considered by the system SIDRA are: the normally accepted range; the standard deviation index (IDS) (Giménez *et al*., 2004); Integrated diagnosis and recommendation system (DRIS) (Beaufils, 1957; 1971; 1973); Modified Integrated diagnosis and recommendation system (M-DRIS) (Jones, 1981; Elwali & Gascho, 1984; Hallmark *et al*., 1987); and Nutrient composition diagnosis (CND) (Parent & Dafir, 1992). The establishment of the reference values is the crucial point to make a diagnosis (Lucena, 1997; Rodríguez & Rodríguez, 2000; Cadahía, 2005). That is why SIDDRA allows elaborating new tables of references for new crops or interpretation systems.

With this system the creation of a **data base** is intended to diagnose and **understand more effectively the foliar, soil and water analysis in order to determine the nutritional requirements for plants**, ensuring the sustainability.

Website

http://www.fertiberia.es/templates/SP.aspx?M=235&F=163

References

Beaufils, E.R. 1957. Research for rational exploitation of Hevea brasiliensis using a physiological diagnosis based on mineral analysis of various parts of the plant. Fertilite. 3:27.

Beaufils, E.R. 1971. Physiological diagnosis. A guide for improving maize production based on principles developed for rubber trees. J. Fert. Soc. S. Afr. 1:1-31.

Beaufils, E.R. 1973. Diagnosis and Recommendation Integrated System (Dris): a general scheme for experimentation and calibration based on principles developed from research in plant nutrition. Soil Science.1:1-132.

Cadahía, C. 2005. Fertirrigación: cultivos hortícolas y ornamentales. 3ª Ed. Mundi-Prensa, Madrid.

Elwali, A.M., Gascho, G.J. 1984. Soil testing foliar analysis, and Dris as guides for sugarcane fertilization. Agron. J. 76:465-470.

Giménez, M., Martínez, J., Ferrández, M., Oltra, M.A., Madrid, R., Rodríguez, V., Rodríguez, O. 2004. Initial values of dris norms for artichoke cv. Blanca de Tudela (Cynara scolymus L.) in the provinces of Alicante and Murcia. Acta Horticulturae.660:285-291.

González-Paloma, J. 2008a. Agricultura sostenible. Balance de nutrientes para un sistema integrado de diagnóstico y recomendación de abonado. 9º Congreso Nacional de Medio Ambiente, Madrid.

González-Paloma, J. 2008b. Sistema Integrado de Diagnóstico y Recomendación de Abonado-SIDDRA. 2ª Jornada Cátedra Fertiberia. Fertilización para uma agricultura sostenible, Madrid.

Hallmark, W., De Mooy, C.J., Pesek, J. 1987. Comparison of two Dris methods for diagnosing nutrient deficiencies. J. of Fertilizer Issues. 4:151-158.

Jones, C. 1981. Proposed modifications of the diagnosis and recommendation integrated system (Dris) for interpreting plant analysis. Communications in Soil Sci. and Plant Analysis. 12:785-794.

Lucena, J.J. 1997. Methods of diagnosis of mineral nutrition of plants a critical review. Acta Horticulturae. 448:179-192.

Parent, L.E., Dafir, E. 1992. A theoretical concept of compositional nutrient diagnosis. J. Amer. Soc. Hort. Sci. 117:239-242.

Rodríguez, O., Rodríguez, V. 2000. Desarrollo, determinación e interpretación de normas DRIS para el diagnóstico nutricional en plantas. Rev. Fac. Agron. 17:449-470.

Appendix 2b SPAIN – Practical Guide for sustainable Crop Fertilisation

Short Description

Practical guide for sustainable crop fertilisation. The practical guidance for rational fertilisation in crops in Spain facilitates training and information for the correct and proper use of fertilisers, both mineral and organic. Its main objective is the **rational fertilisation of crops in Spain**, as a way to get an economically profitable, careful with the environment and, in short, sustainable agriculture.

This publication responds to development of the National Plan of N-fertilisers use reduction. This plan is one of the urgent action of the Spanish strategy for climate change and clean energy, approved by the Council of Ministers on July 20, 2007.

The first step to achieve this objective is the publication of this guide which collects, clearly and concisely, both basic and general concepts about plant nutrition and specific aspects of the fertilization of the most representative of Spanish Agriculture crops.

Publication

Released as a printed book

Website

http://www.magrama.gob.es/es/agricultura/publicaciones/publicaciones-fertilizantes.aspx

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Appendix 3 Flanders - Adaptation and application of the German KNS-system for Flanders

Short Description

In 2013 and 2014, the Flemish Land Agency funded the project 'Documentation and adaption from ecological point of view of the N-recommendation systems in Flanders. The main aim of the project was to ***homogenize the fertilisation recommendations of the different soil N analysis labs for open field vegetables in Flanders****. The German KNS-system, which was already used by the three practical research centres for open field vegetables in Flanders was used as starting point. Before, two mayor systems were used for mineral N recommendations which caused to large differences between the labs.*

The first task was to validate the input data of the KNS-system for Flemish vegetable production. This validation was done based on an extended dataset of N-fertilisation field trials in Flanders. The following input parameters were evaluated: production levels, N-uptake, residual N at harvest, mineralisation and N-release from crops residues and catch crops.

The average Flemish production levels were estimated based on a dataset of hundreds of field trials. The average production levels were used to calculate N-uptake according to the KNS-system. Based on the calculated values of N-uptake, the growth curves of the KNS-system were adapted. The assumption was made that the shape of the growth curve is the same for Flemish vegetable production. The total N-uptake was the only changed factor in the growth curve.

The residual mineral N at harvest was validated based on a dataset with N-dose fertilisation trials. The N-dose trials made it possible to evaluate the residual N at harvest taken into account the yield and quality of the crop at a certain N-dose.

To estimate the mineralisation during the second half of the crop season, data from a previous project (N-meetnet) were used. In this project, a set of 20 fields were monitored. Soil mineral N samples were taken every week on an unfertilised, fallow field. Average weekly mineralisation (in function of planting time) for different soil types (rich in org. C, normal C content, …) could be calculated and included in the adapted KNS-tables for Flanders. The N-release from crop residues and catch crops was also estimated based on field trials.

The adapted KNS-tables for Flanders are collected in one document that **can be used by labs, advisors, … to calculate the fertilisation recommendation**.

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Publication


Het documenteren en milieukundig bijstellen van het KNS en andere bemestingsadviessystemen in de tuinbouw met het oog op een ruimere toepassing in de tuinbouw zoals voorzien in het Actieprogramma 2011-2014

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http://www.vlm.be/SiteCollectionDocuments/Mestbank/Studies/Bemestingsadviessystemen%20tuinbouw/20141114%20eindrapport%20Vlaams%20KNS.pdf

Link to website Flemish Land Agency

http://www.vlm.be/LANDTUINBOUWERS/MESTBANK/STUDIES

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Appendix 4 Bulgaria - Recommendation System for Sustainable vegetable Production in Bulgaria based on 4R Nutrient Stewardship

Using GIS methods, the already available results of soil analyses were allocated to their original areas. The areas selected for the trials were regions for which data was scarce or non-existent. In a subsequent step, soil samples were taken from these selected, representative fields and assessed. Extensive research of publications since 1963 on the effect of nutrients on the soil and on plants was conducted in order to support the practical trials and analyses. The contents of these publications were summarised and included in the assessments.

The resulting manual is an excellent tool for the development of **fertilisation recommendations**. In addition to a project description, it contains information on soil and plant sampling and analysis, as well as recommendations for selecting appropriate fertilisers for vegetables. The most important facts for calculating the appropriate amounts of mineral and organic fertilisers have been summarised in a comprehensible and condensed manner. In addition, the development of special software for advisory services is planned. The intention is to provide this software to farmers, free of charge, in order to support them in implementing their own fertilisation management.

The new recommendation system for Bulgaria is based on **(FRS) is based on the 4 R conception :** 4R Nutrient Stewardship—application of the **Right** nutrient source, at the **Right** rate, at the **Right** time, and in the **Right place**.

Mainly sources we used to prepare FRS are based on IPNI project for Bulgaria - New data from omission plot trials* and Archive data base[a] – literature data from Bulgaria.

Cultivated Plant and Expected yields ($t\ ha^{-1}$)		N	P_2O_5	K_2O	MgO
Tomato* [a]	70	180	80	180	60
	50	220	120	220	70
Potato * [a] Early varieties	50	120	60	140	35
	30	160	80	180	60
Potato * [a] Late varieties	45	150	75	160	50
Pepper * [a]	40	150	80	120	40
	20	200	120	180	60
Cabbage [a]	4	150	120	120	40
Eggplant [a]	5	160	100	100	30
Onion [a]	2	80	60	80	25
Garlic [a]	2	70	50	60	20
Leak [a]	5	150	120	100	30
Carrots [a]	3	100	80	100	30
Spinach [a]	2	80	60	80	25

* * The recommended rates are for good economic results and maintaining the fertility of soils with good nutrient status.

Correction of standard fertilisation rates according to the soil nutrient status – for increasing or maintaining the soil fertility:

- For soils with medium P or K content - correction coefficient 1.2
- For soils with low P or K content - correction coefficient 1.4.
- For soils with very low P or K content - correction coefficient 1.5.

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- For soils with very high P or K content - correction coefficient 0.6.
- Nitrogen fertilizer rates correction for high humus content in the soil – on soils with higher than 2.5% content of humus – correction coefficient – 0.8
- Corrections for organic manure application: Organic manure in tons per ha X nutrient content in kg t^{-1} organic manure.

Placing the focus on sustainable crop nutrition ensures that the practices recommended will not only deal with the immediate needs of the current vegetable crop, but also consider the impact of practices on future crops and the associated economic, social and environmental impacts.

Booklets

Shaban Nidal, Sergey Bistrichanov and I. Mitova: Best Management Practices for Sustainable Crop Nutrition - IPNI project Fertilizer recommendation system for vegetable crops. July 07 - 2014 Sofia Bulgaria

Website

1. http://www.kali-gmbh.com/uken/fertiliser/news/news-20140806-duengeempfehlungen-durch-neues-handbuch-in-bulgarien-leicht-gemacht.html

2. http://ipni.info/IPNI-3372

Stancheva I., I. Mitova, 2002. Effects of Different sources and Fertilizer Rates the Lettuce Yield and Quality under Controlled Conditions. Bul. J. of Agricultural Science, 8,157- 160.

Stoikov Ch., I. Stancheva, I. Mitova, 2003. Growth of Spring Vegetable Plant Seedings in a Phytochamber with a Low Energy Consumption. Bul. J. of Agricultural Science № 9, 651- 657.

Mitova I., I. Stancheva, 2003. Far- Reaching Effects of Increasing rates of the Organic and Mineral Nitrogen Fertilizer on the yield and Some Quality Parameters in Spinach. Ecology and future. Vol. II, № 3- 4, 99- 100.

Stancheva I., I. Mitova, Z. Petkova, 2004. Effects of different nitrogen fertilizer sources on the effects of different nitrogen fertilizer sources on the yield, nitrate content and other physiological parameters in garden beans. Environmental and Experimental Botany. 52, 277- 282.

Kancheva R., C. Nedeva, Iv. Mitova, 2005. Multi- objective optimization of several biological parameters concerning the quality of hot- house tomatoes. Annuaire de l Universite de Sofia St. Kl. Ohridski , Livre 4- 10 Session scientifique, Sofia, 03, Partie II, Tome 96, 59- 62.

Mitova I., K.Simeonov, V. Todorova., 2005. Dinamic of blooming and formation of knots in tomatoes grown over haplic luvisol and in dependence of the form of nitrogen source. Екология и индустрия. т.. 7., N-209- 212.

Mitova Iv., B. Kolev, N. Miteva. 2005.Simple study on solar radiation and greenhouse tomatoes yield relationship. Matematics and Natural Sciences . Proceedings of the International scientific conference, 8- 11.06.2005, Faculty of Mathematics and Natural Sciences- FMNS, Blagoevgrad, Volume2, p. 484- 489.

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Dinev N. Iv. Mitova, V. Netcheva, 2006. Bio- indication of cadmium phytotoxicity on tomato plants depending on soil acidity. Plant science, 43, 377- 382.

Dimitrov I., I. Stancheva, I. Mitova, E. Atanasova,2005. Quality and Yield of Lettuce in Dependence of Different Fertilizer Sources. Bul. Journal of Agricultural Science, 11, 589- 594.

Mitova Iv., R. Kancheva, 2006. The influence of N fertilizer and its soil response on the growth and yield of tomatoes. Proceedings of I[st]. international symposium " Ecological approaches towards the production of safety food ", 19- 20. X. 2006. House of science and technology- Plovdiv. 185- 189.

Dimitrov I., I. Stancheva, I. Mitova, E. Atanasova. 2006. Comparative study of some quality parameters of lettuce in dependence on way of cultivation. Bul. Journal of Agricultural Science, 12, 421- 427.

Mitova I., I. Dimitrov, E. Atanasova, I. Stancheva 2008.· Effects of fore- crop fertilization on the yield and quality of kidney beans under vegetable crop rotation conditions. Acta Agronomica Hungarica 56(4) pp. 67.

Atanasova E., I. Mitova, D. Stoicheva, 2009. Assessment of biochemical and morphological parameters of processing tomatoes in dependence on nitrogen fertilization. Seminar of ecology. Proceedings, 23-24.04.2009, Sofia, 198- 202.

Kancheva R., L. Nenova, Iv. Mitova, 2012. Risk management in the field produktion of cabage. Ecology and health. Proceedings of ninth scientific- technical conference with international participation, 17.05.2012, 175- 178.

Kancheva R., I. Mitova, L. Nenova, 2012. Cost- effectiveness of Potassium Fertilization under Various Deterministic Tomato Varieties and Hybrids . Proceedings international conference „Ecology – interdisciplinary science and practice", 25-26.10.2012, Sofia, 491- 492.

Stefanov D., K. Ananieva, K. Georgieva, N. Dinev, I. Mitova, S. Doncheva, 2012. Rapid Screening of Soil Contamination by using Tomato Plants as Bioindicators. A Pulse Amplitude Modulation Fluorescence Study. Comptes rendus de l׳ Academie bulgare des Sciences, Tome 65, № 10, 1461- 1466

Mitova, I., I. Stancheva, 2013. Effect of fertilizer source on the nutrients biological uptake with garden beans production. *Bulg. J. Agric. Sci., vol.*19: № 5, 947-951.

Dinev N., I.Mitova, 2014. Yield and quality of parsley depend on water quality. Bul. Journal of Agricultural Science. 20. № 2, 111- 115.

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Appendix 5 Republic of Ireland – Green Book

Green Book - Fertiliser advice is aimed at producing optimum crop yields on an annual basis while protecting the environment as well as maximising return on investment for the farmer.

The Major and Micro Nutrient Advice For Productive Agricultural Crops known as the *Green Book* provides **nutrient advice for a wide range of crops grown under Irish conditions**. Nutrient advice starts with taking soil samples to provide a basis for building an effective fertiliser programme. The Green book provides details on taking soil samples to ensure reliable results. Nutrient advice is presented for all major grassland, cereal, root, vegetable and fruit crops.

A revision of the current edition of the Teagasc Green book is planned for 2015 to take into account new research findings for all the major crops plus the integration of recent changes to nutrient legislation.

Web link - http://www.bak.teagasc.ie/soils/The%20Green%20Book.pdf

Note Fertiliser Planning on Irish horticultural Farms:

1. Attention to detail on soils testing and matching crop requirements depending on results
2. Larger more intensive growers are placing P and K
3. More accurate placement machines now in practice for N top dressing
4. A switch from CAN (27%N) to tripicoat (calcium nitrate) to reduce leaf burn
5. More in season foliar analysis being practiced by growers and foliar feeding where required of both major and micro nutrients
6. There would be a large push from sales reps / agronomists to apply foliar feeds without out any appraisal done on pay back / return on investment

Comment from Mark Plunkett

There are numerous reports that soil structure damage is a problem due to machinery size and capacity available on farms now especially on continuous tillage / horticulture soils. This results in poorer rooting and has been compensated for by additional N application. I think we need to get back to looking at crops rotations and what they can add in terms of improving soil structure / nutrient availability – more fresh ground coming into the rotation.

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Appendix 6 Germany – N Expert System

The **computer program N-Expert calculates field specific fertiliser recommendations for vegetable crops.** Since the calculation is based on simple plant growth- and soil-models, which need only few input data, the program can be used by both growers and advisers.

http://www.igzev.de/publikationen/n-expert-a-decision-support-system-for-vegetable-fertilization-in-the-field/

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