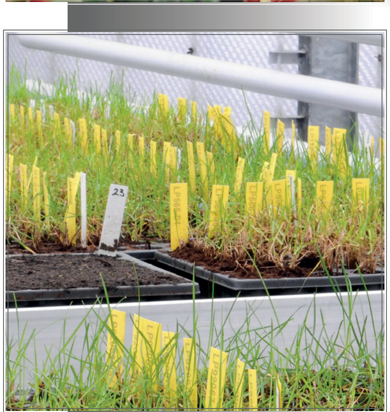


NUTRIHORT

Nutrient management, innovative techniques and nutrient legislation in intensive horticulture for an improved water quality

September 16-18, 2013, Ghent

Fact sheets from the benchmark study on innovative techniques and strategies for reduction of nutrient losses in horticulture

editors

- Fien Amery
- Bart Vandecasteele
- Raf De Vis
- Sara Crappé
- Tomas Van de Sande
- Els Mechant
- Sara De Bolle
- Koen Willekens
- Stefaan De Neve

ISBN: 9789040303470

ISBN: 978-9040303470

Fien Amery, Bart Vandecasteele, Raf De Vis, Sara Crappé, Thomas Van de Sande, Els Mechant, Sara De Bolle, Koen Willekens, Stefaan De Neve, 2013. NUTRIHORT : Nutrient management, innovative techniques and nutrient legislation in intensive horticulture for an improved water quality. Fact sheets from the benchmark study on innovative techniques and strategies for reduction of nutrient losses in horticulture. September 16-18, 2013, Ghent, 130 p.

Table of contents

Introduction

Open field or greenhouse production of vegetables and ornamental plants is challenging because of the need to balance high productivity and sometimes late harvests with reducing nutrient losses to the environment. Growers urgently need to find and implement more sustainable strategies for the intensive production of vegetables, potatoes, flowers and ornamental trees. On request of the European Commission - DG Environment, a consortium of research institutions and extension research centers in Flanders (ILVO, UGent, Inagro, PCS, PCG and PSKW) performed a benchmark study to evaluate innovative techniques for nutrient management in horticulture in Flanders and other regions in Belgium, The Netherlands, France, Spain, Italy, Germany, Denmark, Switzerland and Poland. The benchmark focused on the current knowledge of sustainable and innovative techniques of vegetable and ornamental plant production. The techniques are related to both conventional and organic agriculture, are used both for vegetables and ornamentals, and include applications for horticulture in open air and greenhouse horticulture (both cultures in soil and soilless cultures). The selected techniques focus on innovative fertilization, crop residues management, crop rotation, organic matter management and soil quality practices in horticulture. The necessary information was gathered by visits to the selected regions.

The benchmark resulted in an overview of promising and existing techniques and strategies, compiled in this report. All techniques are presented in clear fact sheets with details on the method, scientific background, involved subsectors and crops, effects on nutrient losses, implementation degree, bottle necks, technical and economic feasibility,…

This compilation of the fact sheets of innovative techniques and strategies will be presented at the international conference 'NUTRIHORT: Nutrient management, innovative techniques and nutrient legislation in intensive horticulture for an improved water quality', 16-18 September 2013, Ghent (Belgium). The position of Flanders relative to other European regions concerning the implementation degree is assessed. For new techniques ready for implementation, the applicability and the economic and technical feasibility for Flanders is evaluated. In the proceedings of the conference, an extended abstract is published including an analysis of and discussion on the techniques. The techniques will be discussed during a workshop at the conference. These results will be used for an action plan for horticulture in Flanders.

Acknowledgements

The fact sheets of innovative techniques and strategies for reduction of nutrient losses in horticulture were composed in collaboration with institutes in the visited European regions. We want to thank for the help of Centre Technique Interprofessionnel des Fruits et Légumes (Bretagne); Station d'Essais de Cultures Légumières (Bretagne); Chambre d'agriculture de Finistère (Bretagne); CATE (Bretagne); Station technique d'expérimentation des plantes en pot (Bretagne); Forschungsinstitut für Biologischen Landbau (Switzerland); Agroscope Changins-Wädenswil (Switzerland); Versuchs- und Beratungsring fur Baumschulen Sleswig Holstein e.V. (Germany); Dienstleistungszentrum Ländlicher Raum Rheinpfalz Neustadt/Weinstraße (Germany); Institut für Gemüse- und Zierpflanzenbau Großbeeren/Erfurt e.V. (Germany); Yara, Duelmen (Germany); Optima Agrik, Polokwane (South Africa); Thomas More (Flanders); Consiglio per la Ricerca e la sperimentazione in Agricoltura – Unità di Ricerca per lo Studio dei Sistemi Colturali (Italy); University of Perugia: Faculty of agriculture (Italy); Wageningen UR (The Netherlands): Plant Research International, Praktijkonderzoek Plant & Omgeving (Vredepeel, Randwijk Nursery Stock and Lisse) and WUR Glastuinbouw; BLGG AgroXpertus (The Netherlands); Stichting Proeftuin Zwaagdijk (The Netherlands); Coexphal, Almería (Spain); University of Almeria, Almeria (Spain); Fundación Cajamar, Research Station Las Palmerillas, El Ejido (Spain), IFAPA, La Mojonera (Spain); Primaflor, Pulpí (Spain); IVIA, Valencia (Spain); Centre d'Essais Horticoles de Wallonie (Wallonia); Centre wallon de Recherches agronomiques Gembloux (Wallonia); Aarhus University - Dept. of Food Science – Årslev (Denmark); Instytut Ogrodnictwa – Inhort Skierniewice (Poland); Centrum Doradztwa Rolniczego (Poland).

Instructions for the reader

This document compiles the facts sheets of innovative techniques and strategies that were collected during the Benchmark study for reduction of nutrient losses in horticulture. The fact sheets were composed by use of the answers on a questionnaire on several aspects of the proposed technique/strategy. All fact sheets have a code, consisting of the abbreviation of the proposing country/region[1] and a number. The fact sheets are ordered alphabetically based on these codes.

Most of the answers are based on expert judgement. Some explanation on the topics in the fact sheets:

- Description: a technical description of the method
- Rationale: Scientific background of how the method works
- Technical feasibility: score between -2 and 2:
  - -2: at least 3 major bottlenecks
  - -1: less than 3 major bottlenecks but more than 1 major or two small bottlenecks
  - 0: at maximum 1 major or two small bottlenecks
  - 1: only one small bottleneck
  - 2: no bottlenecks
- Side effects:
  - +: positive effect
  - 0: neutral/none
  - -: negative effect
- Implementation phase: choice between
  - Idea ready for research
  - Research phase
  - Preliminary field tests
  - Ready for field implementation
  - Implemented at <20% of farms
  - Implemented at >20% of farms
- Expected nutrient use and nutrient loss reduction: choice between
  - n/a (not applicable)
  - small (<10%)
  - average (10-25%)
  - large (25-50%)
  - very large (>50%)
- Timing of the effect for N: choice between
  - Immediately after technique implementation
  - Within three months after start implementation
  - Between three months and one year after start implementation
  - More than one year after start implementation
  - n/a (not applicable)

[1] BR: Bretagne, CH: Switzerland, DE: Germany, Fl: Flanders (Belgium), IT: Italy, NL: The Netherlands, SP: Spain, WA: Wallonia (Belgium).

- Timing of the effect for P: choice between
    - Immediately after technique implementation
    - Within one year after start implementation
    - Between one and three years after start implementation
    - More than three year after start implementation
    - n/a (not applicable)
- Global score for economic feasibility: score between -2 and 2:
    - -2: Yearly costs > 5% of turnover
    - -1: yearly costs are between 2 and 5% of turnover
    - 0: yearly costs are between 0.5 and 2% of turnover
    - 1: yearly costs are between 0.1 and 0.5% of turnover
    - 2: yearly costs <0.1% of turnover

Overview techniques

NL20	Floating cultivation	Deep Flow Technique. Plants are grown in a nutrient solution in tanks/basins with a water depth which varies approximately between 15-35 cm. Plants are fixed in (e.g. polystyrene) floats and develop their roots almost entirely in a nutrient solution. The nutrient solution is circulating and aerated permanently.	113
SP01	Enviroscan (+Triscan)	EnviroSCAN is a soil moisture sensor, based on frequency readings in the soil. Using a default calibration equation it gives data in volumetric water content (mm of water per 100 mm of soil measured). It needs in situ calibration. The TriSCAN sensor provides measurements of both soil water and salinity.	115
SP05	Simulation model of daily crop growth, nutrient uptake and evapotranspiration (Vegsyst)	Vegsyst is a simulation model of daily crop growth, nutrient uptake and evapotranspiration to be used by on-farm decision making support system. This model model requires the input of daily climatic data. It was developed for greenhouse-grown vegetable crops; is being adapted to open field crops.	117
WA01	Use of a recommendation program for the fertilisation planning	Establishment of a N fertilization recommendation based on a provisional N balance sheet method at specific field scale. It assumes a balance between crop N needs and N supply from soil and fertilizers. It requires acquisition of a set of specific data from each field, related to the features of the soil (soil texture, carbon rate, mineral N rate of the profile in layer of 0 to 60 cm at the set up of the crop) and to the husbandry history of the field (previous crop, organic amendments, establishment of a green manure, fate of crop residues, ...) which are considered to estimate soil mineral N supply during the growing season). The methods is applicable for several crop, but was validated specifically for in Wallonia for carrots (Daucus carota), escarole (Cichorium endivia var. latifolia), Welsh onion (Allium fistulosum) and curled-leaved endive (Cichorium endivia var. crispa) .	119
WA02	Management of intercropping period after vegetables crops to reduce N losses through leaching	Catch crops (rye and rye-grass) are sown following vegetable crops (spinach-bean; spinach-spinach succession) that are harvested late autumn. Rye and rye-grass are sown up to 15th of October and ploughed next year in January-February. This technique leads to considerable N reduction in the 1.5m soil profile (up to 80 kg N ha-1) due to rye cover compared to bare soil in march of following year. The planting date is decisive for mineral N recovery of catch crops.	121
WA03	Split the N dose for a higher efficiency	N splitting for four crops : carrot (Daucus carota), escarole (Cichorium endivia var latifolia), Welsh onion (Allium fistulosum) and curled-leave endive (Cichorium endivia var. crispa) experimented in Wallonia. The application of splited N-dosis correspond to periods of highest N-uptake expressed in days after sowing or transplanting.	123
WA04	Determine the level of the additional mineral dressing by use of crop determinations	Follow-up of crop N status (CNS) and decision on the need to apply complementary N. For Welsh onion, the CNS is assessed through leaf nitrate content measurements (using test strips and Nitrachek reflectometer). Threshold value of 2200 ppm (+/- 5%) has been proposed for the period ranging from 40 to 52 days after sowing. For curled-leaved endive, the CNS can be estimated either through leaf nitrate content measurements or through a chlorophyll meter (Hydro N-tester, Yara, Norway). For the nitrate test, threshold values of 2150 ppm (+/- 5%) and 2270 ppm (+/- 5%) have been proposed respectively for the periods ranging from 24 to 31 days after planting and from 33 to 40 days after planting. Similar threshold values for the chlorophyll meter are respectively for both periods 453 and 478.	125

WA05	Composting rejected trees for soil amelioration	Composting rejected trees to make a microbiologically controlled compost. By adding farmyard manure, straw, green material and soil a C/N ratio of 30 is aimed.	127
WA06	Ploughless tillage	Ploughless tillage to reduce compaction. Tests were done to compare ploughing - spading machine - decompactor	129

Techniques for horticulture open air

Code	Technique/strategy name
BR01	designing smart crop rotations
BR02	Smart use of N-fixing green manure
BR03	Equiterre: Advice according to precipitation, pre-crop and crop earliness
BR04	Measuring nitrogen in plant sap
BR05	Determining N mineralization
BR06	Use foliar N fertilisers as top dressing
BR09	Use of compost/mycorhizes in association with reduced fertilisation
CH01	Phosphorus fertilisation with green waste compost
CH02	Winter legumes as green manure crop
CH03	Commercial organic fertilizers
CH04	Irrigation (and also fertilization) management according to soil moisture in strawberry cultivated in soil
DE01	Use of ammonium-stabilized fertilizers
DE02	Use of controlled release fertilizers (CRF)
DE03	Row or point fertilization
DE04	N-Expert / KNS - system
DE05	N-Tester: Small portable chlorophyll meter
DE06	N-sensor: detection of chlorophyll amount of crops
DE07	ImageIT: Digital images to calculate the ground coverage
IT01	Mulching and organic fertilization
IT02	Mixture of legumes and non-legumes as cover crop
IT03	Using local varieties
NL01	Fertigation
NL02	Measuring or estimating the mineral N supply from the soil
NL03	Determine the N need for the crop and farm
NL04	Removal of N-rich crop residues after harvest in early autumn
NL05	Irrigation based on moisture sensor
NL06	Placement of starter P fertilizer in the row or near individual plants
NL07	Replacing sludge manure by mineral fertilizer
NL08	Soilless cropping
NL09	Catch crop
NL10	Fertilization planning
NL11	Placement of starter N fertilizer in the row or near individual plants
NL14	Scientific base for N fertilization recommendation

NL15	Scientific base for P fertilization recommendation
NL20	Floating cultivation
SP01	Enviroscan (+Triscan)
WA01	Use of a recommendation program for the fertilisation planning
WA02	Management of intercropping period after vegetables crops to reduce N losses through leaching
WA04	Determine the level of the additional mineral dressing by use of crop determinations

Techniques for greenhouse horticulture, soilbound

Code	**Technique/strategy name**
BR06	Use foliar N fertilisers as top dressing
BR09	Use of compost/mycorhizes in association with reduced fertilisation
CH01	Phosphorus fertilisation with green waste compost
CH03	Commercial organic fertilizers
CH06	Drain water re-use
DE05	N-Tester: Small portable chlorophyll meter
DE07	ImageIT: Digital images to calculate the ground coverage
IT02	Mixture of legumes and non-legumes as cover crop
IT03	Using local varieties
NL02	Measuring or estimating the mineral N supply from the soil
NL03	Determine the N need for the crop and farm
NL05	Irrigation based on moisture sensor
NL16	Emission management system using lysimeter, moisture sensor, model, software
NL17	waterstreams
SP01	Enviroscan (+Triscan)
SP05	Simulation model of daily crop growth, nutrient uptake and evapotranspiration (Vegsyst)

Techniques for greenhouse horticulture, soilless

Code	Technique/strategy name
BR06	Use foliar N fertilisers as top dressing
BR07	Reuse of drain water (recirculation)
BR08	Use of substrate that temporarily immobilises N
BR09	Use of compost/mycorhizes in association with reduced fertilisation
CH05	Irrigation (and also fertilization) management according to substrate moisture or drain volume in soilless raspberry
CH06	Drain water re-use
DE05	N-Tester: Small portable chlorophyll meter
DE07	ImageIT: Digital images to calculate the ground coverage
FL01	Modified Ion Exchange
FL03	Waste water treatment: Anoxic Moving Bed Bioreactor (MBBR) + phosphate chemisorption filter
IT02	Mixture of legumes and non-legumes as cover crop
IT03	Using local varieties
NL03	Determine the N need for the crop and farm
NL17	waterstreams
NL18	Advanced oxidation
NL19	Membrane destillation, elektrodialysis and capacitive de-ionisation
SP05	Simulation model of daily crop growth, nutrient uptake and evapotranspiration (Vegsyst)

Techniques for soilbound ornamentals

Code	Technique/strategy name
BR06	Use foliar N fertilisers as top dressing
BR09	Use of compost/mycorhizes in association with reduced fertilisation
CH01	Phosphorus fertilisation with green waste compost
CH03	Commercial organic fertilizers
DE01	Use of ammonium-stabilized fertilizers
DE02	Use of controlled release fertilizers (CRF)
DE03	Row or point fertilization
NL01	Fertigation
NL02	Measuring or estimating the mineral N supply from the soil
NL03	Determine the N need for the crop and farm
NL05	Irrigation based on moisture sensor
NL06	Placement of starter P fertilizer in the row or near individual plants
NL11	Placement of starter N fertilizer in the row or near individual plants
NL17	waterstreams
NL18	Advanced oxidation
NL19	Membrane destillation, elektrodialysis and capacitive de-ionisation

Techniques for soilless ornamentals

Code	Technique/strategy name
BR06	Use foliar N fertilisers as top dressing
BR07	Reuse of drain water (recirculation)
BR08	Use of substrate that temporarily immobilises N
BR09	Use of compost/mycorhizes in association with reduced fertilisation
FL01	Modified Ion Exchange
FL03	Waste water treatment: Anoxic Moving Bed Bioreactor (MBBR) + phosphate chemisorption filter
NL03	Determine the N need for the crop and farm
NL12	Soilless cultivation of nursery stock crops - U system
NL13	pot-in-pot system
NL17	waterstreams
NL18	Advanced oxidation
NL19	Membrane destillation, elektrodialysis and capacitive de-ionisation

Code	BR01	Proposing country	**France**	Proposing institution	**CTIFL/SECL**

Name	designing smart crop rotations
Proposing person	Christian Porteneuve ch.porteneuve@wanadoo.fr
Description	Designing smart crop rotations with proper crop sequences (main crop - main crop; main crop - cover crop) for an optimal crop performance and a sustainable agricultural practice.
Rationale	Common goal of smart crop rotations is to optimize nutrient cycling (minimize nutrient losses) and maximize crop yield and quality on a given piece of land by making optimal use of resources.

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	
organic	x

Involved nutrients

N	x
P	

Crops

x	early potatoes*	begonia
	peas	chrysanthemum
	beans	rose tree
x	cauliflower	ornamental tree
	leek	tomatoes
	Brussels sprouts	pepper
	spinach	lettuce
	carrots	strawberries
	onions	flower bed/ balcony
	azalea	indoor plant

other crops: broccoli, artichoke, cereals

crop yield: crop yields (bio): cauliflower 11.000 units (medium size) ha-1, potatoes 15 t ha-1, wheat 5 t ha-1, broccoli 27.000 units (500 g) ha-1, artichoke: 1st year 8 t ha-1, 2nd year 10 t ha-1 and 3th year 10 t ha-1

Action domain

cropping technique	
crop choice/rotation plan	x
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	x
water supply	
drain water	
catch crops	x

Bottlenecks

Costs	x
Labour intensive	x
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: A smart crop rotation implies a more extensive cultivation practice with fewer cash crops (e.g. maximum 40 % cabbages). On the other hand, cycling nutrients and maintaining soil quality reduces the need to use external inputs, which enhances profitability. So far, legumes are not permitted as a catch crop in Brittany, France. However legislation will change so that it will be allowed to sow legumes in a mixture, e.g. with grasses or cereals.

Side effects for

organic carbon	0
weed and/or diseases	+
water use	-
other	0

details side effects:

score technical feasibility: 0

Details technical feasibility: For organic growers a smart crop rotation is a conditio sine qua non for ensuring crop quality.

Implementation

Phase: Implemented at >20% of farms

Degree: 60

Organic matter content in horticultural soils in Brittany is 2.5 till 3.0 %. Only multiyear grassland, which does not occur in these rotations, and muncipal waste compost may increase organic matter content. Side effects for water use may be '-' or '+'. On one hand, the utilization of water by the intercrop may cause a deficit for the autumn cash crop but, on the other hand, it may delay leaching in autumn.	Details: 60 % of the organic horticultural area in Brittany belongs to farms with larger crop rotations and 3-4 main crops; the other 40 % belongs to small scale farms with a more diversified product range and limited use of green manures or intercrops

Expected effects on nutrient use and nutrient losses

		Effect timing on	
N use reduction:	average (10-25%)	Soil N:	immediately after technique implementation
P use reduction:	n/a	Soil P:	n/a
details nutrient use reduction:			
N loss reduction:	average (10-25%)	Surface groundwater N:	within three months after start
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:		details:	

Effect crop yield or quality

Effect:	increase
Details and timing:	The increase only concerns crop quality and not yield because this organic system implies a more extensive cultivation practice.

Costs for investment, production and labour	Smart crop rotations imply extra costs.
Global score economic feasibility	0
Details about the economic feasability	Compared to an intensive (conventional) cultivation practice an extensive (organic) one may be less profitable, however, it will be more sustainable as it saves natural resources and maintains soil quality.
Knowledge gaps	Additional research is needed on managing N availability by the cultivation system in order to prevent high residual N contents
References	
National or regional studies	

Code	BR02	Proposing country	France	Proposing institution	CTIFL/SECL

Name: Smart use of N-fixing green manure

Proposing person: Christian Porteneuve ch.porteneuve@wanadoo.fr

Description: 1. White clover sown in March under a cereal persists after cereal harvest and supplies N to a winter cauliflower crop in the next growing season (July-February); 2. Mixture of faba beans and peas sown in November-December after corn is incorporated in April and supplies N for an autumn cauliflower crop planted in June and 3. Sowing mixtures of cereals and legumes in autumn as a green manure, e.g. before spring broccoli crop (March-June).

Rationale: Legume crops are useful as intercrop or cover crop. On one hand, they fix atmospheric N and on the other, they store nutrients and transfer them to the main crop after incorporation of the legume crop.

Subsector

- horticulture open air x
- greenhouse horticulture soil
- greenhouse horticulture soilless
- ornamentals soil
- ornamentals soilless

Farming system

- conventional x
- organic x

Involved nutrients

- N x
- P

Crops

	early potatoes*	begonia
	peas	chrysanthemum
	beans	rose tree
x	cauliflower	ornamental tree
	leek	tomatoes
	Brussels sprouts	pepper
	spinach	lettuce
	carrots	strawberries
	onions	flower bed/ balcony
	azalea	indoor plant

other crops: broccoli

crop yield: crop yields (bio): cauliflower 11.000 units (medium size) ha-1, broccoli 27.000 units (500 g) ha-1

Action domain

- cropping technique
- crop choice/rotation plan x
- fertilisation planning x
- fertiliser type
- fertilisation technique
- crop residues x
- water supply
- drain water
- catch crops x

Bottlenecks

- Costs x
- Labour intensive x
- Knowledge intensive for farmer
- Knowlegde gaps in research x
- Increased risk of crop yield reduction
- Increased risk of crop quality reduction
- Legislation x
- Other

Details: Additional research is needed on measures to control N availability out of incorporated legumes (e.g. white clover). So far, legumes are not permitted as a catch crop in Brittany, France. However legislation will change so that it will be allowed to sow legumes in a mixture, e.g. with grasses or cereals.

score technical feasibility: 0

Details technical feasibility:

Side effects for

- organic carbon 0
- weed and/or diseases +
- water use -
- other 0

details side effects:

Only multiyear grassland, which does not occur in these rotations, and muncipal waste compost may increase organic matter content.

Implementation

Phase: Implemented at >20% of farms

Degree: 60

Details: 60 % of the organic horticultural area in Brittany belongs to farms with legumes included in larger crop rotations; the other 40 % belongs to small scale farms with a more diversified product range and limited use of legumes as green manure

Expected effects on nutrient use and nutrient losses

N use reduction:	very large (>50%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	small (<10%)
P loss reduction:	n/a
details nutrient loss reduction:	The goal of an ingenious crop rotation is to reduce N losses, however, control of N availability out of legumes is not that simple (export of a full grown cut or sowing cereals in the leguminous crop are possible measures); planting density and variety choice with regard to the main crop will limit nutrient requirements and so nutrient losses

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	n/a
Surface groundwater N:	within three months after start
Surface groundwater P:	n/a
details:	

Effect crop yield or quality

Effect:	increase
Details and timing:	The increase only concerns crop quality and not yield because this organic system implies a more extensive cultivation practice.

Costs for investment, production and labour	sowing leguminous green manures imply extra costs.
Global score economic feasibility	0
Details about the economic feasability	Compared to an intensive (conventional) cultivation practice an extensive (organic) one may be less profitable, however, it will be more sustainable as it saves natural resources and maintains soil quality.
Knowledge gaps	More research is needed to obtain local references. The aim is to reduce N excess in autumn, however, a certain risk using organic, vegetal fertilization wil remain. A research issue is the assesment of N availability in subsequent main crops due to incorporation of a leguminous green manure (e.g. a spring crop broccoli (March-June) followed by a cauliflower (July-December).
References	
National or regional studies	http://www.itab.asso.fr/

Code	BR03	Proposing country	France	Proposing institution	Chambre d'agriculture de Finistère/CATE
Name	Equiterre: Advice according to precipitation, pre-crop and crop earliness				
Proposing person	Jean Luc Péden [jluc.peden@finistere.chambagri.fr]				
Description	Advice according to precipitation (leaching), pre-crop field history (rich, medium or poor) and crop earliness. The system is based on mineral N analyses on demand (2-3 horizons, labo and nitrachek). N is applied 2-3 times before harvest in case of minor N availability.				
Rationale	Equiterre is a simplified plant-soil N balance approach to avoid excess				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*	begonia
	peas	chrysanthemum
	beans	rose tree
x	cauliflower	ornamental tree
x	leek	tomatoes
	Brussels sprouts	pepper
	spinach	lettuce
	carrots	strawberries
x	onions	flower bed/ balcony
	azalea	indoor plant
other crops:	artichoke	
crop yield:		

Action domain

cropping technique	
crop choice/rotation plan	x
fertilisation planning	x
fertiliser type	x
fertilisation technique	
crop residues	x
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	
Details:	Global cost for the system, not charged to the farmers

score technical feasibility: 0

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	0
other	0
details side effects:	

Implementation

Phase:	Implemented at >20% of farms
Degree:	65-75%
Details:	

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)	**Effect timing on**	
P use reduction:	n/a	Soil N:	immediately after technique implementation
details nutrient use reduction:	Since advice is based on assessment of N availabality on reference fields, expected nutrient use reduction is limited.	Soil P:	n/a
N loss reduction:	small (<10%)	Surface groundwater N:	between three months and one year after start

P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:	Since advice is based on assessment of N availabality on reference fields, expected nutrient loss reduction is limited.	details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	28 reference fields, 6 samplings per growing season, i.e. 1 per month
Global score economic feasibility	2
Details about the economic feasability	Costs spent for the system are not charged to the farmers.
Knowledge gaps	Additional investigation of soil related processes on reference fields for better understanding of N dynamics
References	Decoopman, B., Le Roux, L. et Péden, J.L. (2008) Fertilisation des légumes frais de plein champ. Chambres d'Agriculture Bretagne, 47 p.
National or regional studies	

Code	BR04	Proposing country	France	Proposing institution	CTIFL & CATE
Name	Measuring nitrogen in plant sap				
Proposing person	Christian Porteneuve (ch.porteneuve@wanadoo.fr), François Orsini (francois.orsini@cate.fr)				
Description	Plant N availability is assessed by measurement of nitrate in sap of plant leaf or stem tissue. This technique can be applied either with a field device or a laboratory equipment.				
Rationale	Plant roots absorb N as nitrate which is stored temporary before being used for the photosynthesis of organic compounds. Nitrate content in plant sap reflects plant available N in soil solution. Plant sap nitrate measurement can be used to decide on mineral N top dressing. This assessment method of the plant N availability is straightforward and more sensitive.				

Subsector

- horticulture open air x
- greenhouse horticulture soil
- greenhouse horticulture soilless
- ornamentals soil
- ornamentals soilless

Farming system

- conventional x
- organic x

Involved nutrients

- N x
- P

Crops

	early potatoes*	begonia
	peas	chrysanthemum
	beans	rose tree
x	cauliflower	ornamental tree
	leek	tomatoes
	Brussels sprouts	pepper
	spinach	lettuce
	carrots	strawberries
	onions	flower bed/ balcony
	azalea	indoor plant

other crops: Applicable for late cauliflower crops that might need a mineral N top dressing in spring

crop yield:

Action domain

- cropping technique
- crop choice/rotation plan
- fertilisation planning x
- fertiliser type
- fertilisation technique
- crop residues
- water supply
- drain water
- catch crops

Bottlenecks

- Costs
- Labour intensive x
- Knowledge intensive for farmer x
- Knowlegde gaps in research x
- Increased risk of crop yield reduction
- Increased risk of crop quality reduction
- Legislation
- Other

Details: Plant sap nitrate measurements are more laborious than Nitracheck® (soil nitrate measurement) and the latter is already known by the growers

score technical feasibility: -2

Details technical feasibility:

Side effects for

- organic carbon 0
- weed and/or diseases +
- water use 0
- other 0

details side effects:

Implementation

Phase: Research phase

Degree:

Details: On farm field tests to validate research results are needed, however, fund raising is necessary and difficult as acceptance of the technique is supposed to be rather low.

Expected effects on nutrient use and nutrient losses

N use reduction: small (<10%)

P use reduction: n/a

details nutrient use reduction: Nowadays, a standard dose

Effect timing on

Soil N: immediately after technique implementation

Soil P: n/a

N loss reduction:	small (<10%)	Surface groundwater N:	between three months and one year after start
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:		details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Costs for measurement devices and some labour
Global score economic feasibility	
Details about the economic feasability	
Knowledge gaps	Validation of research results in practice is still required.
References	
National or regional studies	

Code	BR05	Proposing country	France	Proposing institution	CATE
Name	Determining N mineralization				
Proposing person	Michel Leroux (michel.leroux@cate.fr), François Orsini (francois.orsini@cate.fr)				
Description	N fertilization based on crop requirement and amount of N released from soil organic matter or crop residues				
Rationale	Research for understanding processes and factors affecting N mineralization and for determination of 1) periods of high N mineralization 2) periods of risk for N leaching 3) key moments for soil sampling under common horticultural practice, to be implemented in N fertilizer advice systems.				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
x	cauliflower		ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: artichoke and maize

crop yield: artichoke 8-9 t /ha /year for the 3-year period (higher yield in 2nd and 3th growing season compared to 1st growing season); cauliflower 10.000-12.000 units /ha (all sizes, small 400-600g, medium 600-800g, large 800-1200g) at a plant density of 12.000-15.000 plants /ha

Action domain

cropping technique	
crop choice/rotation plan	x
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	x
water supply	
drain water	
catch crops	x

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Ongoing research on N mineralisation in relation to certain cultivation measures

score technical feasibility: -1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	0
other	0

details side effects:

Implementation

Phase:

Degree:

Details: Research results are or will be implemented in the Equiterre advice system

Expected effects on nutrient use and nutrient losses

N use reduction: average (10-25%)

P use reduction: n/a

Effect timing on

Soil N: immediately after technique implementation

details nutrient use reduction:		Soil P:	n/a
N loss reduction:	average (10-25%)	Surface groundwater N:	between three months and one year after start
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:	Besides the understanding of the N mineralization in a system, the extent of the N loss reduction will be related to the applied cultivation measures based on the understanding of the N availability in the system.	details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Costs for research and for implementation of research results in Equiterre system.
Global score economic feasibility	2
Details about the economic feasability	Costs spent are not charged to the farmers.
Knowledge gaps	Additional research on N availability in relation to newly introduced cultivation measures
References	1. Report CATE 'Contribution à une meilleure maîtrise de l'azote sur cultures leguminières dans le contexte pédo-climatique du Nord Finistère; travaux réalisés depuis 1983; 2. - Akkal-Corfini, N.; Morvan, T.; Menasseri-Aubry, S.; et al. (2010). Nitrogen mineralization, plant uptake and nitrate leaching following the incorporation of (15N)-labeled cauliflower crop residues (Brassica oleracea) into the soil: a 3-year lysimeter study. PLANT AND SOIL 328: 17-26
National or regional studies	

Code	BR06	Proposing country	**France**	Proposing institution	**STEPP**

Name: Use foliar N fertilisers as top dressing

Proposing person: Oscar Stapel, stepp_bretagne@astredhor.fr

Description: Certain fertilizers can be absorbed effectively by the vegetation. This technique is used to respond rapidly after discovering nutrient shortages in crops. The fertiliser solution can be applied with a pesticide sprayer

Rationale: Many plants can absorb small compounds like nutrients by the leaves. The beneficial impact of

this fertiliser application method is often much earlier visible than nutrient uptake by the roots.

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	x
ornamentals soil	x
ornamentals soilless	x

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas	x	chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions	x	flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	x
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: This fertiliser type is usually more expensive than fertilisers designed for root uptake

score technical feasibility: 2

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	0
other	0

details side effects:

Application of fertilisers directly on the vegetation may reduce disease pressure in 2 ways : by destroying directly mycelium and spores and/or by triggering plant defense mechanisms

Implementation

Phase: Implemented at <20% of farms

Degree: 5-15%

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)
P use reduction:	small (<10%)
details nutrient use reduction:	
N loss reduction:	large (25-50%)
P loss reduction:	large (25-50%)

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	immediately after technique implementation
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	between one and three years after start

details nutrient loss reduction:	Much less leaching from the substrate	details:	This technique allows less leaching from the substrate

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	sprayer
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	
References	Technical reports of ASTREDHOR experiment stations
National or regional studies	

Code	BR07	Proposing country	France	Proposing institution	STEPP
Name	Reuse of drain water (recirculation)				
Proposing person	Oscar Stapel, stepp_bretagne@astredhor.fr				
Description	Ferti-irrigation of potted plants on tablets by a closed flooding system. By capillairy force the substrate absorbs the fertiliser solution in a certain time period (defined by the grower) and the remaining solution is drained from the tablets in a recycling system for reuse in the next watering period. With conductivity measurements extra fertilisation can be added in the reused solution.				
Rationale	Closed horticultural system that avoids spillage of fertiliser solution in the environnement.				

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	x

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

	early potatoes*	x	begonia
	peas	x	chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions	x	flower bed/ balcony
	azalea	x	indoor plant

other crops:

crop yield: The technique is already applied in potted plant production

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	x
fertilisation technique	x
crop residues	
water supply	
drain water	x
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	x
Legislation	
Other	

Details: Relatively high investment as related to other more common ferti-irrigation techniques. Risks related to disease propagation

score technical feasibility: 1

Details technical feasibility: Technique is already well established in potted plant production (small pots)

Side effects for

organic carbon	0
weed and/or diseases	-
water use	+
other	0

details side effects:
A desinfection system is needed to avoid propagation of soil born diseases

Implementation

Phase: Implemented at >20% of farms

Degree: 20

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	very large (>50%)
P use reduction:	very large (>50%)
details nutrient use reduction:	reduction 50-90% (N, P) as related to sprinkler ferti-irrigation without drain water
N loss reduction:	very large (>50%)

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	immediately after technique implementation
Surface groundwater N:	immediately after technique implementation

P loss reduction:	very large (>50%)	Surface groundwater P:	immediately after technique implementation
details nutrient loss reduction:	reduction 50-90% (N, P) as related to sprinkler ferti-irrigation without drain water	details:	Implementation of a closed ferti-irrigation system has immediate effects on the environmental impact

Effect crop yield or quality

Effect:	increase
Details and timing:	Plants show less fertiliser residues on the leaves
Costs for investment, production and labour	approximately 30 Euros/m2
Global score economic feasibility	0
Details about the economic feasability	0
Knowledge gaps	Pathogen desinfection techniques (ex : UV-C treatments) are used but these existing techniques are usually expensive. Considering the economically difficult situation in ornamental horticulture this technique may nowadays be too expensive for many ornamental crops
References	ASTREDHOR, Synthèse journée technique : Le recyclage de l'eau en horticulture, 128 pages
National or regional studies	National and regional studies performed and ongoing in ASTREDHOR experiment stations on

Code	BR08	Proposing country	France	Proposing institution	STEPP
Name	Use of substrate that temporarily immobilises N				
Proposing person	Oscar Stapel, stepp_bretagne@astredhor.fr				
Description	Adaptation of horticultural substrate formulations using materials with high C/N ratio (e.g. wood fibers) in order to diminish N leaching.				
Rationale	Nitrogen tends to leach from classical peat substrate formulations, when combined with commercially available organic fertilisers, approximately 3 to 6 weeks after planting. Capturing nitrogen during that period by incorporationg substances with a high C/N ratio may help in temporary immobilizing part of the excess nitrogen. This immobilized N should become available to the plant later on.				

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	x

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*	x	begonia
	peas	x	chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions	x	flower bed/ balcony
	azalea		indoor plant

other crops: Cyclamen, Petunia

crop yield: Application possible for many potted plant species

Action domain

cropping technique	x
crop choice/rotation plan	
fertilisation planning	
fertiliser type	x
fertilisation technique	x
crop residues	
water supply	
drain water	x
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	x
Legislation	
Other	

Details: Management of mineralisation processes in soilless horticultural crops. Higher temperatures in greenhouses increase mineralisation processes when using organic fertilizers especially in periods that high N availability is not desired.

score technical feasibility: -1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	0
other	0

details side effects:
Substrates with micro-organisms involved in mineralisation of organic fertilisers seem to suppress the impact of soil born diseases, a beneficial effect that will be studied in future projects.

Implementation

Phase: Preliminary field tests

Degree:

Details: 2-5% of horticultural productions use organic fertilization (sometimes in addition to classical fertilisation), especially in bedding plants cultures and young plant production for vegetables.

Expected effects on nutrient use and nutrient losses

N use reduction: average (10-25%)

P use reduction: average (10-25%)

details nutrient use reduction: New substrate formulations

Effect timing on

Soil N: immediately after technique implementation

Soil P: immediately after technique implementation

N loss reduction:	large (25-50%)	Surface groundwater N:	immediately after technique implementation
P loss reduction:	large (25-50%)	Surface groundwater P:	immediately after technique implementation
details nutrient loss reduction:	Less N loss in organic fertiliser application by changing substrate formulations may reduce significantly N loss as related to the substrate formulations used today. It is still too early to estimate expected nutrient loss reduction by using organic fertilisers. Today leaching of N is very important because actual substrate compositions are not adapted and growers have a tendency to irrigate abundantly at long intervals. In our studies we compare nutrient loss of organic fertilisers with the use of chemically derived fertilisers for horticulture.		

Effect crop yield or quality

Effect:	no effect
Details and timing:	Because of difficulties in managing mineralisation of organic fertilisers, plants in badly adapted substrates tend to show signs of nutrient deficiency after approximately 2 months.
Costs for investment, production and labour	The adapted composition of the substrate is expected to have a minor impact on substrate price.
Global score economic feasibility	1
Details about the economic feasability	No investments needed
Knowledge gaps	Technically it is possible to develop substrates that help diminish N leaching but the impact on plant quality my be detrimental for certain formulations. More research is needed to find the best compromise.
References	Experiment reports of the ASTREDHOR experiment stations (CDHRC, GIEFPSO, AGE, STEPP)
National or regional studies	

Code	BR09	Proposing country	France	Proposing institution	STEPP

Name	Use of compost/mycorhizes in association with reduced fertilisation
Proposing person	Oscar Stapel, stepp_bretagne@astredhor.fr
Description	The combined use of compost and mycorrhiza has a positive effect on plant growth and development of some ornamental crops. Especially woody plants showed better root developpement at lower fertilisation rates.
Rationale	Scientific papers have shown that symbiotic mycorrhiza/plant interactions make it possible to reduce fertilisation rates in certain plant species. Reduced P fertilisation is required for a successful installation of the microorganism. Inoculation has to be done as soon as possible, preferably at sowing/planting. The endomycorrhiza Glomus intraradices can penetrate and colonize quickly the root system of the hostplant and increases the plants capability of obtaining nutriens in exchange for sugar compounds.

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	x
ornamentals soil	x
ornamentals soilless	x

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
x	beans		rose tree
	cauliflower	x	ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
x	onions	x	flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield:

Action domain

cropping technique	x
crop choice/rotation plan	
fertilisation planning	
fertiliser type	x
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Use of mycorrhiza in potted horticulture is still new. Specific growing conditions must be optimized to increase the efficacy, many factors are still unknown.

score technical feasibility: -2

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	+
other	0

details side effects:

Possible deminished disease pressure (under investigation)

Implementation

Phase: Implemented at <20% of farms

Degree: 2

Details: Many companies in France offer mycorhiza to the growers, but effects on many ornamental plants are still unclear. Further experimentation under production conditions is needed to show beneficial effects.

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	large (25-50%)
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	large (25-50%)
details nutrient loss reduction:	

Effect timing on

Soil N:	within three months after start implementation
Soil P:	within one year after start implementation
Surface groundwater N:	within three months after start implementation
Surface groundwater P:	within one year after start implementation
details:	

Effect crop yield or quality

Effect:	increase
Details and timing:	better rooting

Costs for investment, production and labour	No investement needed
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	More research needed to identify the optimal conditions
References	Technical reports of ASTREDHOR experiment stations
National or regional studies	

Code	CH01	Proposing country	**Switzerland**	Proposing institution	**FiBL**

Name	Phosphorus fertilisation with green waste compost
Proposing person	Martin Koller
Description	Phosphorus fertilisation with limited amounts of compost from green manure
Rationale	If compost is applied only based on P2O5 demand -at least in Switzerland - P leaching (mainly by erosion) could be reduced considerably. Moreover compost helps to build up soil structure and therefore reduces the surface erosion additionally (P leaching through the soil profile is not considered to be very important in Swiss soils)

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	
P	x

Crops

x	early potatoes*		begonia
x	peas		chrysanthemum
x	beans		rose tree
x	cauliflower	x	ornamental tree
x	leek	x	tomatoes
x	Brussels sprouts	x	pepper
x	spinach	x	lettuce
x	carrots	x	strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops: basically in all soil bound crops

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	x
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	x
Other	

Details: Compost addition is limited to 25 ton DM/ha per 3 years and furthermore by the P norm (which differs between crops)

score technical feasibility: 1

Details technical feasibility:

Side effects for

organic carbon	+
weed and/or diseases	+
water use	0
other	0

details side effects:

b) positive: disease suppression

Implementation

Phase: Implemented at >20% of farms

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	n/a
P use reduction:	large (25-50%)
details nutrient use reduction:	Because of replacement of mined P
N loss reduction:	n/a
P loss reduction:	small (<10%)
details nutrient loss reduction:	

Effect timing on

Soil N:	n/a
Soil P:	within one year after start implementation
Surface groundwater N:	n/a
Surface groundwater P:	between one and three years after start
details:	Answers are applicable for green waste compost only

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Relatively low, compost could be spread by contractor. Price for 30 m3 (yearly amount of compost) is between 0 and 350 Euro; costs for spreading are arround 150 Euro per ha (prices in Switzerland)
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	
References	
National or regional studies	

Code	CH02	Proposing country	**Switzerland**	Proposing institution	**FIBL**
Name	Winter legumes as green manure crop				
Proposing person	Martin Koller (martin.koller@fibl.org)				
Description	Winter legume (e.g. forage pea) green manure crops might deliver 50-100 kgN/ha to the following crop				
Rationale	In 3 years studies for various vegetable crops the nitrogen transfer of winter legume green manure to the following crop was studied. A nitrogen transfer in some cases of 50 to 100 kg N/ha was found.				

Subsector

- horticulture open air x
- greenhouse horticulture soil
- greenhouse horticulture soilless
- ornamentals soil
- ornamentals soilless

Farming system

- conventional
- organic x

Involved nutrients

- N x
- P

Crops

	early potatoes*	begonia
	peas	chrysanthemum
	beans	rose tree
x	cauliflower	ornamental tree
x	leek	tomatoes
	Brussels sprouts	pepper
	spinach	lettuce
	carrots	strawberries
	onions	flower bed/ balcony
	azalea	indoor plant

other crops:
crop yield:

Action domain

- cropping technique
- crop choice/rotation plan x
- fertilisation planning
- fertiliser type
- fertilisation technique
- crop residues
- water supply
- drain water
- catch crops x

Bottlenecks

- Costs x
- Labour intensive
- Knowledge intensive for farmer
- Knowlegde gaps in research
- Increased risk of crop yield reduction x
- Increased risk of crop quality reduction
- Legislation
- Other

Details: Winter legumes establishment even as green manure is costly (seeds and labor = 250 Euro per ha), if the plot has to be used earlier than planned (e.g. changes in crop rotation due to weather conditions) or the green manure didn't grow sufficiently in time, the investment doesn't pay back directly

score technical feasibility: -1

Details technical feasibility: "Nitrogen yield" is depending very much on the weather condition in spring

Side effects for

- organic carbon 0
- weed and/or diseases +
- water use 0
- other 0

details side effects:
Weed reduction, but risk of increase of some diseases; water use might differ considerably from one year to another.

Implementation

Phase: Ready for field implementation
Degree:
Details:

Expected effects on nutrient use and nutrient losses

N use reduction: average (10-25%)
P use reduction: small (<10%)
details nutrient use reduction: Recycling of nutrients, especially N, in the soil

Effect timing on

Soil N: immediately after technique implementation
Soil P: n/a

N loss reduction:	small (<10%)	Surface groundwater N:	between three months and one year after start
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:	Recycling of nutrients, especially N, in the soil	details:	Positive effects of N accumulation could be used by the following crop, N reduction in groundwater can take place, because it is a "slow release fertilizer"

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Growing a green manure crop
Global score economic feasibility	0
Details about the economic feasability	
Knowledge gaps	
References	Der Gemüsebau/Le Maraîcher 6/2010 p. 24-25
National or regional studies	

Code	CH03	Proposing country	Switzerland	Proposing institution	FIBL
Name	Commercial organic fertilizers				
Proposing person	Martin Koller (martin.koller@fibl.org)				
Description	Commercial organic nitrogen fertilizers (e.g feather powder) release the nitrogen relatively slow				
Rationale	Commercial organic nitrogen fertilizers (e.g feather powder) release the nitrogen relatively slow (up to 70 % of N-totale within 4 weeks after application at 20 °C). The plant need and the fertilizer mineralization are therefore in a certain synchronisation (at least in late spring and summer).				

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	
organic	x

Involved nutrients

N	x
P	

Crops

x	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
x	cauliflower		ornamental tree
x	leek	x	tomatoes
x	Brussels sprouts	x	pepper
x	spinach	x	lettuce
	carrots		strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops:
crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	x
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: Costs are up to five times higher compared to mineral fertilizers

score technical feasibility: 1
Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	0
other	0

details side effects:
Weed reduction, but risk of increase of some diseases; water use might differ considerably from one year to the other.

Implementation

Phase: Implemented at >20% of farms
Degree:
Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	small (<10%)
details nutrient use reduction:	Most of these fertilisers have very low P content (<0,5%)
N loss reduction:	small (<10%)
P loss reduction:	n/a
details nutrient loss reduction:	Normal levels of residual nitrogen measured after harvest

Effect timing on

Soil N:	within three months after start implementation
Soil P:	n/a
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	n/a
details:	Organic fertilizers have slower release of N in the soil, creating a better synchronization with plant growth. But wet and cold conditions could further postpone the release.

Effect crop yield or quality	
Effect:	decrease
Details and timing:	Slight decrease compared to conventional fertilizer (but the latter are restricted in use for organic growers), because of too slow release of N under certain conditions (cold, wet) and application of lower amounts of nutrients (because of high cost)
Costs for investment, production and labour	More expensive fertilizer, up to five times higher compared to mineral fertilizer
Global score economic feasibility	-1
Details about the economic feasability	High costs for organic fertilizer
Knowledge gaps	
References	
National or regional studies	

Code	CH04	Proposing country	Switzerland	Proposing institution	Agroscope Changins-Wädenswil
Name	Irrigation (and also fertilization) management according to soil moisture in strawberry cultivated in soil				
Proposing person	Celine Gilli, celine.gilli@agroscope.admin.ch				
Description	This technique makes automatic irrigation, based on the use of a sensor which measures soil moisture, possible. This technique is tested and compared with the use of a tensiometer, which measures water retention, for automatic irrigation.				
Rationale	This technique allows a reduction of nutrients use, water use and also labor. For most of the growers, irrigation is not automatically done. Soil humidity is checked 'by experience'.				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots	x	strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	x
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: Variety of soil types could be a bottleneck. For automatic irrigation, a threshold value should be defined to start irrigation. When this threshold value is determined by soil moisture content, you need a threshold value for each type of soil where you want to use the technique. For threshold values based on water retention, you only need one value which is usable for different types of soil.

score technical feasibility: 2

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	+
other	+

details side effects:
Less labor

Implementation

Phase: Ready for field implementation

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	average (10-25%)
details nutrient use reduction:	
N loss reduction:	small (<10%)
P loss reduction:	small (<10%)
details nutrient loss reduction:	

Effect timing on

Soil N:	within three months after start implementation
Soil P:	within one year after start implementation
Surface groundwater N:	within three months after start implementation
Surface groundwater P:	within one year after start implementation
details:	

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	1500 €/ irrigation sector
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	Automatical stop of the irrigation when the soil humidity is high enough
References	Ançay A., Baroffio C., Michel V. Comparaison de deux méthodes de gestion de l’irrigation des fraises, in press. Revue suisse de viticulture, arboriculture et horticulture.
National or regional studies	

Code	CH05	Proposing country	Switzerland	Proposing institution	Agroscope Changins-Wädenswil

Name	Irrigation (and also fertilization) management according to substrate moisture or drain volume in soilless raspberry
Proposing person	Celine Gilli, celine.gilli@agroscope.admin.ch
Description	The aim of this study is to reduce drain water in soilless raspberry. Growers would like to obtain only 5% of drain water. Different drain water volumes are tested: 5%, 10-15% and 15-20%
Rationale	This technique is based on a better supply of water and nutrient.

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

early potatoes*	begonia
peas	chrysanthemum
beans	rose tree
cauliflower	ornamental tree
leek	tomatoes
Brussels sprouts	pepper
spinach	lettuce
carrots	strawberries
onions	flower bed/ balcony
azalea	indoor plant

other crops: raspberry

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	x
drain water	x
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Salinisation of the soil due to too low amount of drain.

score technical feasibility: -1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	0

details side effects:

Implementation

Phase: Research phase

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	large (25-50%)
P use reduction:	large (25-50%)
details nutrient use reduction:	
N loss reduction:	small (<10%)
P loss reduction:	small (<10%)
details nutrient loss reduction:	

Effect timing on

Soil N:	n/a
Soil P:	n/a
Surface groundwater N:	immediately after technique implementation
Surface groundwater P:	immediately after technique implementation
details:	

Effect crop yield or quality

Effect: no effect

Details and timing:

Costs for investment, production and labour	4000
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	
References	
National or regional studies	

Code	CH06	Proposing country	Switzerland	Proposing institution	Agroscope Changins-Wädenswil
Name	Drain water re-use				
Proposing person	Celine Gilli, celine.gilli@agroscope.admin.ch				
Description	In Switzerland drain water must be (re)used in agriculture or horticulture according to the state of the art and to the compliance with environmental requirements. For example, drain water of gerbera may be reused on rose. Or drain water of tomato, is reused in soil tomato production. This technique is still in practice				
Rationale					

Subsector

- horticulture open air
- greenhouse horticulture soil x
- greenhouse horticulture soilless x
- ornamentals soil
- ornamentals soilless

Farming system

- conventional x
- organic

Involved nutrients

- N x
- P x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield:

Action domain

- cropping technique
- crop choice/rotation plan
- fertilisation planning
- fertiliser type
- fertilisation technique
- crop residues
- water supply
- drain water x
- catch crops

Bottlenecks

- Costs
- Labour intensive
- Knowledge intensive for farmer
- Knowlegde gaps in research
- Increased risk of crop yield reduction
- Increased risk of crop quality reduction
- Legislation
- Other x

Details: It is important to reuse the drain water of one crop on a crop that is not sensitive for diseases. For example, gerbera is quite sensitive for diseases, but roses are not, therefore drainwater of gerbera can be reused on roses but not vice versa.

score technical feasibility: 2

Details technical feasibility:

Side effects for

- organic carbon 0
- weed and/or diseases 0
- water use 0
- other 0

details side effects:

Implementation

Phase: Implemented at >20% of farms

Degree:

Details: This is an 'old' technique that is already used in practice for several years

Expected effects on nutrient use and nutrient losses

N use reduction: small (<10%)

P use reduction: small (<10%)

details nutrient use reduction: In the crop where the drain water is reused, there is a reduction in the use of nutrients.

Effect timing on

Soil N: n/a

Soil P: n/a

N loss reduction:	small (<10%)	Surface groundwater N:	n/a
P loss reduction:	small (<10%)	Surface groundwater P:	n/a
details nutrient loss reduction:		details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	
References	
National or regional studies	

Code	DE01	Proposing country	Germany	Proposing institution	VuB (Versuchs- und Beratungsring Baumschulen)

Name	Use of ammonium-stabilized fertilizers
Proposing person	Hendrik Averdieck (averdieck@vub.sh
Description	Ammonium-stabilized fertilizers can be used earlier in spring than normal NPK-fertilizers, because the danger of nitrogen-loss is lower. The ammonium is protected for 4-6 weeks from being transformed into nitrate.
Rationale	The Fertilizer ENTEC or NOVATEC contain the component 3,4-dimethylpyrazolphosphat, that impede the bacteria Nitrosomonas, inhibiting the nitrification process. Ammonium is bound in the soil and is less prone to washing out compared to nitrate.

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans	x	rose tree
	cauliflower	x	ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops:
crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	x
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 2

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase: Implemented at >20% of farms

Degree: The ammonium stabilized fertilizers are used by about 80% of the nurseries. The degree of implementation is about 90-100% in that companies.

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	n/a
details nutrient loss reduction:	

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	n/a
Surface groundwater N:	within three months after start implementation
Surface groundwater P:	n/a
details:	

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	The stabilized fertilizer is about 5% more expensive than normal NPK-fertilizer
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	Influence on microorganisms when using several years
References	
National or regional studies	

Code	DE02	Proposing country	Germany	Proposing institution	VuB (Versuchs- und Beratungsring Baumschulen)

Name	Use of controlled release fertilizers (CRF)
Proposing person	Hendrik Averdieck (averdieck@vub.sh)
Description	Controlled release fertilizers for the open field are partly coated. The total amount of nitrogen, that is necccessary for a crop, is given in spring.
Rationale	Because of the coating, the nutrients are released at a constant rate during the growing season. There are products with only coated nitrogen but there are also products with coated nitrogen, phosphorus and potassium

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans	x	rose tree
	cauliflower	x	ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops:
crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	x
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 0

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase: Implemented at <20% of farms

Degree: the use of controlled release fertilizers is implemented at less than 20% of companies. At those companies, the degree of implementation is about 30-40%. CRF's are mostly used for more expensive crops.

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	small (<10%)
details nutrient use reduction:	
N loss reduction:	large (25-50%)
P loss reduction:	small (<10%)

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	immediately after technique implementation
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	within one year after start implementation

details nutrient loss reduction:	details:
Effect crop yield or quality	
Effect:	increase
Details and timing:	The growth of seedlings and shrubs is often stronger and more evenly. On the occurence of diseases, no effects are observed.
Costs for investment, production and labour	The controlled release fertilizers are about 50-60% more expensive than normal NPK-fertilizers
Global score economic feasibility	-1
Details about the economic feasability	
Knowledge gaps	
References	
National or regional studies	

Code	DE03	Proposing country	Germany	Proposing institution	VuB (Versuchs- und Beratungsring Baumschulen)

Name: Row or point fertilization

Proposing person: Hendrik Averdieck (averdieck@vub.sh)

Description: The fertilizer is applicated in a row near the crop or it is placed point-like at the plants

Rationale: The advantage of this method is, that the fertilizer is located close to the plants. The nutrient level between the plants is low. The risk of nutrient leaching is lower compared to broadcast application.

Subsector

Subsector	
horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

Farming system	
conventional	x
organic	

Involved nutrients

Nutrient	
N	x
P	x

Crops

early potatoes*			begonia
peas			chrysanthemum
beans		x	rose tree
cauliflower		x	ornamental tree
leek			tomatoes
Brussels sprouts			pepper
spinach			lettuce
carrots			strawberries
onions			flower bed/ balcony
azalea			indoor plant

other crops:

crop yield:

Action domain

Action domain	
cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	x
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Bottleneck	
Costs	x
Labour intensive	x
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 1

Details technical feasibility:

Side effects for

Side effect	
organic carbon	0
weed and/or diseases	+
water use	0
other	0

details side effects:

Implementation

Phase: Implemented at <20% of farms

Degree: The degree of implementation in the farms that use the technique is about 30-40%.

Details:

Expected effects on nutrient use and nutrient losses

N use reduction: large (25-50%)

P use reduction: large (25-50%)

details nutrient use reduction:

N loss reduction: large (25-50%)

P loss reduction: average (10-25%)

details nutrient loss reduction:

Effect timing on

Soil N: immediately after technique implementation

Soil P: between one and three years after start implemen

Surface groundwater N: within three months after start implementation

Surface groundwater P: between one and three years after start

details:

Effect crop yield or quality

Effect: no effect

Details and timing:

Costs for investment, production and labour	Necessary adjustments to the machine that applies fertilizer, application takes more time.
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	Influence on root growth
References	
National or regional studies	

Code	DE04	Proposing country	Germany	Proposing institution	DLR Rheinpfalz, Neustadt/Wstr. IGZ, grossbeeren
Name	N-Expert / KNS - system				
Proposing person	Matthias Fink (fink@igzev.de), Joachim Ziegler (joachim.ziegler@dlr.rlp.de				
Description	Intensive use of mineral N soil analyses, crop specific N-target values before planting and during growth if necessary and taking N-mineralisation (soil humus, residues previous crop) into account; intensifying crop rotation with special catch crops (high C/N-ratio)				
Rationale	Carmen Feller, Matthias Fink, Hermann Laber, Achim Maync, Peter-J. Paschold, Hans-Christoph Scharpf, Josef Schlaghecken, Klaus Strohmeyer, Ulrike Weier und Joachim Ziegler, 2011: Düngung im Freilandgemüsebau, 3.Auflage, IGZ Großbeeren				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans	x	rose tree
	cauliflower	x	ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
x	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
x	azalea		indoor plant

other crops: Advisory system for 45 different vegetable species in about 170 different situations (early planting, late planting, high yield…)

crop yield: very different yields, large amount of crops

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	x
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 2

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase: Implemented at >20% of farms

Degree: implementation degree: when used, used on 100% of vegetable production fields

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	n/a

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	n/a
Surface groundwater N:	within three months after start implementation
Surface groundwater P:	n/a

details nutrient loss reduction:	details:
Effect crop yield or quality	
Effect:	increase
Details and timing:	Compared to farmers practice, the percentage of marketable plants is about 5% higher. Total DM production remains equal.
Costs for investment, production and labour	average cost for one crop (professional soil sample and Nmin-analysis): ~ 40,- EUR
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	calculation, modelling N-mineralisation after measurement
References	Lorenz, H.P., J. Schlaghecken, G. Engl, A. Maync, J. Ziegler und K. Strohmeyer, 1989: Ordnungsgemäße Stickstoffversorgung im Freiland-Gemüsebau nach dem "Kulturbegleitenden
National or regional studies	Armbruster, M, N. Laun und F. Wiesler, 2010: Entwicklung eines Stickstoff-Managementsystems

Code	DE 05	Proposing country	**Germany**	Proposing institution	**YARA**

Name	N-Tester: Small portable chlorophyll meter
Proposing person	Joerg Jasper (joerg.jasper@yara.com)
Description	Small portable chlorophyll meter (based on SPAD 502). Used for measuring chlorophyll concentration in the culture (usually on the youngest fully eveloped leaf). 30 measurements are necessary for determining the nutritional satus of the crop and the formation of a fertilisation advice. Requires calibration in field trials.
Rationale	The N-Tester measures the light transition through a leaf at two wavebands (650 nm and 960 nm). The light extinction at 650 nm is due to chlorophyll light absorption. The measurement at 960 nm is used to correct for leaf thickness. So, the reading gives information about the chlorophyll concentration in the leaf, which is closely related to the leaf's N content. In order to use this measurement for the derivation of N fertilizer recommendations a strict sampling protocol needs to be followed (e.g. measurement at the central part of the youngest fully developed leaf) and variety correction factors to compensate for genetic differences in chlorphyll content (dark green and bright green varieties) need to be developed.

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

early potatoes*	begonia
peas	chrysanthemum
beans	rose tree
cauliflower	ornamental tree
leek	tomatoes
Brussels sprouts	pepper
spinach	lettuce
carrots	strawberries
onions	flower bed/ balcony
azalea	indoor plant

other crops: cereals, potatoes and many others

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	x
Legislation	
Other	

Details: In horticulture : just - in time fertilisation may lead to temporary shortages?

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

score technical feasibility: ?

Details technical feasibility:

Implementation

Phase:

Degree:

Details:

Expected effects on nutrient use and nutrient losses			
N use reduction:		Effect timing on	
P use reduction:		Soil N:	
details nutrient use reduction:		Soil P:	
N loss reduction:		Surface groundwater N:	
P loss reduction:		Surface groundwater P:	
details nutrient loss reduction:		details:	
Effect crop yield or quality			
Effect:			
Details and timing:			
Costs for investment, production and labour			
Global score economic feasibility			
Details about the economic feasability			
Knowledge gaps			
References			
National or regional studies			

Code	DE 06	Proposing country	Germany	Proposing institution	YARA

Name: N-sensor: detection of chlorophyll amount of crops

Proposing person: Joerg Jasper (joerg.jasper@yara.com)

Description: Detection of a crop's green biomass (chlorophyll amount) by measuring the light reflection of the crop. Measurement either 'passive' (N-Sensor, using daylight) or 'active' (N-Sensor ALS with artificial light source). Measurement of spatial differences in crop condition allows spatially differentiated application of nitrogen fertilisers (and other inputs). On-field calibration for cereals with the N-Tester.

Rationale: Light reflectance properties of crop canopies change with changing nitrogen status of the crop. Better N supply improves the growth (biomass production) and chlorphyll content (greenness) of crops. More biomass is causing increasing light reflectance in the near-infrared spectral range, where light is scatered and reflected by cell wall components. Higher cholorphyll content in the canopy means increased light absorption and lower reflectance values in the visible spetral range. Light reflectance measurement in the visible/IR range (spectral index or vegetation index) therefore gives information about biomass and chlorophyll content of the crop.

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
x	cauliflower		ornamental tree
x	leek		tomatoes
x	Brussels sprouts		pepper
	spinach		lettuce
x	carrots		strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops: winter wheat, potatoes, oiseed rape, maize

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: ?

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase:

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:

Effect timing on

P use reduction:	Soil N:
details nutrient use reduction:	Soil P:
N loss reduction:	Surface groundwater N:
P loss reduction:	Surface groundwater P:
details nutrient loss reduction:	details:

Effect crop yield or quality

Effect:

Details and timing:

Costs for investment, production and labour

Global score economic feasibility

Details about the economic feasability

Knowledge gaps

References

National or regional studies

Code	DE 07	Proposing country	**Germany**	Proposing institution	**YARA**

Name	ImageIT: Digital images to calculate the ground coverage
Proposing person	Joerg Jasper (joerg.jasper@yara.com)
Description	Smartphone APP combining input about the culture and field (expected yield, potential mineralisation ...) with photographs of the crop in order to formulate a fertilisation advice.
Rationale	Digital images of a crop, having been taken with the camera of a smartphone looking straight downwards and sent to a central server, are processed in order to discriminate between crop and soil background and to calculate the ground coverage of the crop (percentage). From the ground coverage either the biomass or N uptake of a certain crop at a certain growth stage can be estimated based on empirical relationships, determined in field trials.

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
x	cauliflower		ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: oilseed rape, maize and cereals at early growth stages, …

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: ?

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase:

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:

P use reduction:

details nutrient use reduction:

N loss reduction:

P loss reduction:

details nutrient loss reduction:

Effect timing on

Soil N:

Soil P:

Surface groundwater N:

Surface groundwater P:

details:

Effect crop yield or quality	
Effect:	
Details and timing:	
Costs for investment, production and labour	
Global score economic feasibility	
Details about the economic feasability	
Knowledge gaps	
References	
National or regional studies	

Code	FL01	Proposing country	Belgium (Flanders)	Proposing institution	Optima Agrik
Name	Modified Ion Exchange				
Proposing person	Ockie van Niekerk				
Description	Ion exchange technology is used to absorb the nutrients and the sodium chloride from the discharged nutrient solution. In the process desalinized water is made that can be used by the grower. The sodium and the chloride can then be separated from the nutrients making use of the higher selectivity that the ion exchange resins have for some of the nutrients. Lastly the resins are regenerated with chemicals chosen for their nutritional value. This makes it possible to re-use the nutrients again.				
Rationale	This technology offers many alternative ways of operation. A simplified version of one alternative will be discussed here. After the ions have been absorbed onto the resin the chloride is removed from the anion resin by pumping a diluted sulfuric acid through the column. The hydrochloric acid solution that is generated in the process is neutralized with lime to form a calcium chloride solution (to be used later). Thereafter the resin is regenerated with ammonium hydroxide to form a mixture of ammonium based fertilizer. The anion resin is then ready for the next cycle. The calcium chloride solution that was generated as described earlier is then used to remove the sodium from the cation exchange resin. Thereafter the resin is regenerated with nitric acid to make calcium nitrate that can be used as a fertilizer.				

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	x

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

x	early potatoes*	x	begonia
x	peas	x	chrysanthemum
x	beans	x	rose tree
x	cauliflower	x	ornamental tree
x	leek	x	tomatoes
x	Brussels sprouts	x	pepper
x	spinach	x	lettuce
x	carrots	x	strawberries
x	onions	x	flower bed/ balcony
x	azalea	x	indoor plant

other crops:
crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	x
drain water	x
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: 1) The technology still needs to be tested on lab scale; 2) It will have be determined how to implement this process on small scale operations.

score technical feasibility: -1
Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	0
details side effects:	

Implementation

Phase: Research phase
Degree:
Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	n/a
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	very large (>50%)
P loss reduction:	very large (>50%)
details nutrient loss reduction:	

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	immediately after technique implementation
Surface groundwater N:	immediately after technique implementation
Surface groundwater P:	immediately after technique implementation
details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	

Costs for investment, production and labour	Must be organised on sector scale, very large investment for a plant, low cost at farm level
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	The process makes use of available knowledge that is already known. It needs to be tested and optimised.
References	PCT published patent application no WO/2011/104669 and corresponding national application numbers:
National or regional studies	

Code	FL03	Proposing country	Belgium (Flanders)	Proposing institution	Thomas More
Name	Waste water treatment: Anoxic Moving Bed Bioreactor (MBBR) + phosphate chemisorption filter				
Proposing person	Nico Lambert - Thomas More - O&O Chemie - Campus De Nayer				
Description	Innovative robust end-of-pipe purification strategy, able to remove nitrate and phosphorus out of nutrient wastewater flows of greenhouses.				
Rationale	The AnoxKaldnes™ MBBR technology is based on the biofilm principle with an active biofilm growing on small specially designed plastic carriers that are kept suspended in a denitrification reactor. In order to ensure a high efficiency of the denitrification reaction, the MBBR reactor is operated in anoxic conditions. Because of the lack of readily biodegradable COD in the influent the addition of an external carbon source for denitrification is necessary. A sodium acetate based commercial carbon source (BIOAid®, Dow Chemical Company) is used and is dosed at a 5 mg COD/mg NO3-N ratio in the MBBR. To compensate the H+ consumption during the denitrification reaction, the pH is kept constant at 7.3 – 7.5 by addition of HCl (5%). A technology based on phosphate adsorption was applied as a technically simple alternative post treatment for conventional physicochemical phosphate removal processes. It concerns a specific chemical adsorption (or also called chemisorption) process. Due to the characteristics of a purification process based on a solid support, less post-processing is necessary than with a conventional physicochemical phosphate removal process, which requires the high efficient separation of the formed phosphate sludge. The solid support material used in this research is granular iron with a sand core. This material is derived from rapid sand filters used for the production of drinking water from groundwater, and is considered as a solid waste product for the drinking water company.				

Subsector		Crops			
horticulture open air			early potatoes*		begonia
greenhouse horticulture soil			peas		chrysanthemum
greenhouse horticulture soilless	x		beans		rose tree
ornamentals soil			cauliflower		ornamental tree
ornamentals soilless	x		leek	x	tomatoes
Farming system			Brussels sprouts	x	pepper
conventional	x		spinach	x	lettuce
organic			carrots	x	strawberries
Involved nutrients			onions	x	flower bed/ balcony
N	x		azalea	x	indoor plant
P	x	other crops:	all soillessly grown crops		
		crop yield:			

Action domain		Bottlenecks	
cropping technique		Costs	
crop choice/rotation plan		Labour intensive	
fertilisation planning		Knowledge intensive for farmer	
fertiliser type		Knowlegde gaps in research	
fertilisation technique		Increased risk of crop yield reduction	
crop residues		Increased risk of crop quality reduction	
water supply		Legislation	
drain water	x	Other	x

catch crops	Details: The discharge standard of 1 ppm PO4-P is very low but if an optimization on the basis of the inclusion of rest periods and longer residence times in the phosphate filter is taken into account, than it is possible to meet the discharge limit.The underlying cause can be explained by the interparticle diffusion of PO4-P towards the core of the grain during the rest periods and the longer residence times in the filter. This will result in fresh and free adsorption sites, which leads to the fact that the grains less rapidly saturate. Further optimization of the control strategy of the dosing of the carbon source for denitrification in the MBBR, can prevent overdosing of the carbon source and thus reduce costs. A simple measurement of pH, conductivity or redox potential during the denitrification process can provide a solution.
Side effects for	
organic carbon: 0	score technical feasibility: 1
weed and/or diseases: 0	Details technical feasibility:
water use: +	**Implementation**
other: 0	Phase: Research phase
details side effects:	Degree:
	Details: Both techniques are investigated on a pilot scale and are both ready for the market

Expected effects on nutrient use and nutrient losses

N use reduction:	n/a	**Effect timing on**	
P use reduction:	n/a	Soil N:	n/a
details nutrient use reduction:	neutral	Soil P:	n/a
N loss reduction:	very large (>50%)	Surface groundwater N:	immediately after technique implementation
P loss reduction:	very large (>50%)	Surface groundwater P:	immediately after technique implementation
details nutrient loss reduction:	Treatment of 30-50 m3/ha wastewater on a total use of about 12,000 m3/ha, which is now often discharged in surface water		

Effect crop yield or quality

Effect:	no effect
Details and timing:	

Costs for investment, production and labour	Estimate of the operating costs of the water treatment plant: 3.3 €/kg NO3-N, of which 2.1 €/kg NO3-N is due to the cost of the carbon source.
Global score economic feasibility	2
Details about the economic feasability	estimate of the operating costs of the water treatment plant: 3.3 €/kg NO3-N, of which 2.1 €/kg NO3-N is due to the cost of the carbon source.
Knowledge gaps	Reseach for reduction of phosphorus level below norm for discharge in surface water
References	(1) Moelants N., Smets I.Y., Van Impe J.F., 2011. The potential of an iron rich substrate for phosphorus removal in decentralized wastewater treatment systems. Separation and Purification Technology, Volume 77, Issue 1, 2 February 2011, Pages 40-45. (2) Aspegren H., Nyberg U., Andersson B., Gotthardsson S., Jansen J., 1998. Post denitrification in a moving bed biofilm reactor process. Water Science and Technology, Volume 38, Issue 1, 1998, Pages 31-38.
National or regional studies	ADLO project: "Telen zonder spui" - Belgium

Code	IT01	Proposing country	Italy	Proposing institution	Consiglio per la Ricerca e la sperimentazione in Agricoltura - Unità di Ricerca per lo Studio dei Sistemi Colturali
Name	Mulching and organic fertilization				
Proposing person	Francesco Montemurro, francesco.montemurro@entecra.it				
Description	The technique is a combination of the mulching of a leguminous crop with the application of organic fertilizer based on composting of waste materials.				
Rationale	The cropping cycle of cover crops is terminated in advance of its physiological conclusion (mulching) by mechanical methods (roller-crimper). The amount of N delivered to the cropping system by legume cover crops is integrated with organic amendments.				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: zucchini, melon

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	x
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	x
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: -2

Details technical feasibility:

Side effects for

organic carbon	+
weed and/or diseases	+
water use	+
other	0

details side effects:

Implementation

Phase: Preliminary field tests

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	large (25-50%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	n/a
details nutrient loss reduction:	

Effect timing on

Soil N:	between three months and one year after start
Soil P:	n/a
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	n/a
details:	

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	To apply this technique there are initial investments cost for mulching (roller-crimper). For the organics amendments it is possible to find some commercial materials.
Global score economic feasibility	-2
Details about the economic feasability	
Knowledge gaps	Since this technique is in a implementation phase, some studies are needed on plant performance and soil properties
References	1. Leogrande R., Lopedota O., Montemurro F., Ciaccia C., Fiore A., Scazzariello R., Quaranta A., Canali, S. 2011. Vetch cover crop management and organic fertiliser application in organic zucchini production: I. Effect on yield and produce quality. Proceeding of the Third Scientific Conference of ISOFAR, Namyangju, Korea, 28 September – 01 October: 170-173; 2. Ciaccia C., Tittarelli F., Lopedota O., Leogrande R., Montemurro F., Canali, S. 2011. Vetch cover crop management and organic fertiliser application in organic zucchini production: II. Effect on weed presence and crop-weed competition. Proceeding of the Third Scientific Conference of ISOFAR, Namyangju, Korea, 28 September – 01 October: 174-177; 3. There are two papers submitted on international journals
National or regional studies	National study: ORWEEDS project

Code	IT02	Proposing country	Italy	Proposing institution	University of Perugia : Faculty of agriculture
Name	Mixture of legumes and non-legumes as cover crop				
Proposing person	Francesco Tei, ftei@unipg.it				
Description	This technique combines the use of legumes as cover crop with non legumes				
Rationale	Using mixtures proved to be a very effective strategy for the management of winter cover crops, because barley and vetch complement each other very well, as the grass is capable of high growth rates during the cold season, while vetch becomes very important in spring, when N becomes the limiting factor. Changing the proportion of species within the mixture can be a key factor to adjust the extent and timing of N mineralisation to the nutritional requirements of the following crop. Likewise, changing the above proportion can be very important to ensure a good quality of the incorporated biomass (with particular reference to C/N ratio), which is fundamental for a good initial growth and N status of the subsequent cash crop.				

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops: maize

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	x
water supply	
drain water	
catch crops	x

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

Side effects for

organic carbon	+
weed and/or diseases	+
water use	+
other	0

details side effects:

score technical feasibility: 1

Details technical feasibility:

Implementation

Phase: Ready for field implementation

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction: large (25-50%)

P use reduction: n/a

details nutrient use reduction:

Effect timing on

Soil N: between three months and one year after start

Soil P: n/a

N loss reduction:		Surface groundwater N:	between three months and one year after start
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:	No tests were done	details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	mixing seeds before seeding
Global score economic feasibility	0
Details about the economic feasability	Farmers have to adopt the technique
Knowledge gaps	
References	Green manuring effect of pure and mixed barley – hairy vetch winter cover crops on maize and processing tomato N nutrition Giacomo Tosti, Paolo Benincasa, Michela Farneselli , Roberta Pace, Francesco Tei, Marcello Guiducci, Kristian Thorup-Kristensen, European journal of Agronomy, 2012,43,136-146
National or regional studies	

Code	IT03	Proposing country	Italy	Proposing institution	Consiglio per la Ricerca e la sperimentazione in Agricoltura - Unità di Ricerca per lo Studio dei Sistemi Colturali

Name	Using local varieties
Proposing person	Francesco Montemurro, francesco.montemurro@entecra.it
Description	Using local varieties of legumes, sometimes ancient varieties
Rationale	Farmers and research were faced with more deseases. Therefore more and more local varieties are tested/used since they are more resistent and have a better production under the "local" conditions. This can involve better/less use of nutrients.

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops: melon

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	x
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	+
other	0

details side effects:

Implementation

Phase: Ready for field implementation

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction: n/a

P use reduction: n/a

details nutrient use reduction:

N loss reduction:

P loss reduction:

details nutrient loss reduction:

Effect timing on

Soil N: n/a

Soil P:

Surface groundwater N: n/a

Surface groundwater P:

details:

Effect crop yield or quality

Effect: no effect

Details and timing:

Costs for investment, production and labour	no real extra costs
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	commercial potential of the local varieties
References	1. Leogrande R., Lopedota O., Montemurro F., Ciaccia C., Fiore A., Scazzariello R., Quaranta A., Canali, S. 2011. Vetch cover crop management and organic fertiliser application in organic zucchini
National or regional studies	

Code	NL01	Proposing country	**The Netherlands**	Proposing institution	**PRI**
Name	Fertigation				
Proposing person	Frank de Ruijter, frank.deruijter@wur.nl				
Description	Fertigation is the combination of fertilization (in solution) and irrigation.				
Rationale	Nitrogen is usual given as solid fertilizer and/or foliar application. Under dry conditions N is difficult to take up from the soil. If N is given in solution, via fertigation, it can be directly taken up by the crop. With a fertigation system this fertilization can be given during the whole growing season when needed. With this system it is possible to optimize the dose and efficiency of N fertilization, with consequently reduced N losses. Sometimes the yield is positively affected due to the good water supply resulting in larger N export by the crop, a smaller N excess and a larger effectivity. For trees, fertigation gives only N profit in the second year since the crop doesn't need a N gift in the first year given a desirable mineral N soil content of 50-70 kg and organic manuring.				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower	x	ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots	x	strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	x
fertilisation technique	x
crop residues	
water supply	x
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	x
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Due to the high costs of drip irrigation (material, installation, removal) this method can only be applied for crops with large profit (trees, strawberry). During the growing season, regular control of the whole system is needed.

score technical feasibility: -1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	0

details side effects:

Implementation

Phase: Implemented at <20% of farms

Degree: More than 60% of the farms with strawberries use fertigation. For flowerbulbs the application is less (1-5%), as for trees (4%).

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)	**Effect timing on**	
P use reduction:	n/a	Soil N:	immediately after technique implementation
details nutrient use reduction:		Soil P:	n/a
N loss reduction:	small (<10%)	Surface groundwater N:	within three months after start implementation
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:	Good application of the technique is imperative	details:	

Effect crop yield or quality

Effect:	increase
Details and timing:	Sometimes the yield is positively affected due to the good water supply resulting in larger N export by the crop, a smaller N excess and a larger effectivity.

Costs for investment, production and labour	High costs of drip irrigation (material, installation, removal), therefore this method can only be applied for crops with large profit (trees, strawberry)
Global score economic feasibility	-1
Details about the economic feasability	
Knowledge gaps	None
References	Smit, A., de Ruijter, F. J., de Haan, J. J., and Paauw, J. G. M. 2011. Maatregelen ter vermindering van de nitraatuitspoeling en de mate van toepassing in de praktijk. 2239, Alterra, Wageningen.
National or regional studies	

Code	NL02	Proposing country	**The Netherlands**	Proposing institution	**PRI**

Name	Measuring or estimating the mineral N supply from the soil
Proposing person	Frank de Ruijter, frank.deruijter@wur.nl
Description	The mineral N supply can be determined by soil analysis. When the analysis results are always similar or can be related to the previous crop and/or weather conditions, it can also be estimated.
Rationale	If the supply of mineral N in spring is known, it can be subtracted from the basic gift, resulting in reduced N input and consequently lower N loss.

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

x	early potatoes*	x	begonia
x	peas	x	chrysanthemum
x	beans	x	rose tree
x	cauliflower	x	ornamental tree
x	leek	x	tomatoes
x	Brussels sprouts	x	pepper
x	spinach	x	lettuce
x	carrots	x	strawberries
x	onions	x	flower bed/ balcony
x	azalea	x	indoor plant

other crops: all crops

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: none

score technical feasibility: 2

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase: Implemented at >20% of farms

Degree: A lot of farmers estimate the mineral N supply (sometimes 90%), but measurement is less performed (sometimes <5%, 25% for horticulture in soil according to expert judgement). According to a questionnaire among farmers, +/- 50% of the farmers measure the mineral N content.

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	n/a
details nutrient loss reduction:	

Effect timing on

Soil N:	within three months after start implementation
Soil P:	n/a
Surface groundwater N:	within three months after start implementation
Surface groundwater P:	n/a
details:	

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Minimal (soil N analysis)
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	
References	Smit, A., de Ruijter, F. J., de Haan, J. J., and Paauw, J. G. M. 2011. Maatregelen ter vermindering van de nitraatuitspoeling en de mate van toepassing in de praktijk. 2239, Alterra, Wageningen.
National or regional studies	

Code	NL03	Proposing country	**The Netherlands**	Proposing institution	**PRI**

Name: Determine the N need for the crop and farm

Proposing person: Frank de Ruijter, frank.deruijter@wur.nl

Description: Determine the N requirements for the crop and farm based on fertilizer recommendations (guidelines for N fertilization per crop and differentiated to soil type)

Rationale: Rational N use is possible if one knows the N need of the crop. Additional reductions in N use and consequently N loss are possible if you know the N mineralisation to be expected, the mineral N content of the soil at start of the crop and the N requirements of the variety. When manure is used for several years, the rest effect of N from manure can also be taken into account.

Subsector
- horticulture open air x
- greenhouse horticulture soil x
- greenhouse horticulture soilless x
- ornamentals soil x
- ornamentals soilless x

Farming system
- conventional x
- organic x

Involved nutrients
- N x
- P

Crops
- x early potatoes*
- x peas
- x beans
- x cauliflower
- x leek
- x Brussels sprouts
- x spinach
- x carrots
- x onions
- x azalea
- x begonia
- x chrysanthemum
- x rose tree
- x ornamental tree
- x tomatoes
- x pepper
- x lettuce
- x strawberries
- x flower bed/ balcony
- x indoor plant

other crops:

crop yield:

Action domain
- cropping technique
- crop choice/rotation plan x
- fertilisation planning x
- fertiliser type x
- fertilisation technique x
- crop residues x
- water supply x
- drain water
- catch crops x

Bottlenecks
- Costs
- Labour intensive
- Knowledge intensive for farmer
- Knowlegde gaps in research
- Increased risk of crop yield reduction
- Increased risk of crop quality reduction
- Legislation
- Other x

Details: A basic fertilization plan can be made by every farmer

score technical feasibility: 2

Details technical feasibility:

Side effects for
- organic carbon 0
- weed and/or diseases 0
- water use 0
- other 0

details side effects:

Implementation
Phase: Implemented at >20% of farms

Degree: A large part of the farms (70-88%) determine the N need but the basis of this determination varies widely

Details:

Expected effects on nutrient use and nutrient losses
N use reduction: average (10-25%)

P use reduction: n/a

details nutrient use reduction:

N loss reduction: average (10-25%)

P loss reduction: n/a

details nutrient loss reduction:

Effect timing on
Soil N: within three months after start implementation

Soil P: n/a

Surface groundwater N: between three months and one year after start

Surface groundwater P: n/a

details:

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Minimal (soil N determination)
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	If the expected N from mineralisation is estimated in more detail beforehand, a larger saving on N-input can be achieved without increasing the risk of yield reduction
References	Smit, A., de Ruijter, F. J., de Haan, J. J., and Paauw, J. G. M. 2011. Maatregelen ter vermindering van de nitraatuitspoeling en de mate van toepassing in de praktijk. 2239, Alterra, Wageningen.
National or regional studies	

Code	NL04	Proposing country	The Netherlands	Proposing institution	PRI
Name	Removal of N-rich crop residues after harvest in early autumn				
Proposing person	Frank de Ruijter, frank.deruijter@wur.nl				
Description	Crop residues are removed at or after crop harvest in early autumn.				
Rationale	Removal of N-rich crop residues from the field in autumn strongly reduces nitrate leaching in winter. To prevent nitrate leaching at other places, the residues have to be processed. Anaerobic digestion enables nutrients to be stored until the next spring. Composting is also possible, but a large part of the nitrogen is lost to the air.				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
x	peas		chrysanthemum
	beans		rose tree
x	cauliflower		ornamental tree
x	leek		tomatoes
	Brussels sprouts		pepper
	spinach	x	lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: broccoli

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	x
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	x
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: Adapted harvest machines are necessary, costs for composting, in some cases extra fertilization is needed in spring, possible damage to the soil structure caused by crop residue removing machinery under unfavourable conditions

score technical feasibility: -2

Details technical feasibility:

Side effects for

organic carbon	-
weed and/or diseases	0
water use	0
other	-

details side effects:

If the composted crop residues are not returned to the soil, it is possible that the %C in the soil reduces. This effect will be minimal since there is not much stable organic carbon in N-rich crop residues. Other negative effects: possible structure damage.

Implementation

Phase: Ready for field implementation

Degree:

Details: Studies with positive results are performed, but the bottlenecks are too large for implementation.

Expected effects on nutrient use and nutrient losses

N use reduction: n/a

P use reduction: n/a

details nutrient use reduction:

Effect timing on

Soil N: immediately after technique implementation

Soil P: immediately after technique implementation

N loss reduction:	large (25-50%)	Surface groundwater N:	within three months after start implementation
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:		details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Adapted harvest machines are necessary. There are costs for labour, composting (20€/ton) and in some cases for the extra fertilization in spring.
Global score economic feasibility	-2
Details about the economic feasability	
Knowledge gaps	
References	Smit, A., de Ruijter, F. J., de Haan, J. J., and Paauw, J. G. M. 2011. Maatregelen ter vermindering van de nitraatuitspoeling en de mate van toepassing in de praktijk. 2239, Alterra, Wageningen. De Ruijter, F.J. 2012. Afvoer en verwerking van N-rijke gewasresten - vergisting en compostering. Wageningen, PRI, Rapport 433 De Ruijter, F J, A.L. Smit & H.F.M. ten Berge 2007 Het lot van stikstof uit gewasresten. Wageningen, Plant Research International. Rapport 133, F.J. de Ruijter (2008) Nitraatuitspoeling uit gewasresten van broccoli, prei en suikerbiet. BO-05-infoblad-23 (http://edepot.wur.nl/2708)
National or regional studies	

Code	NL05	Proposing country	**The Netherlands**	Proposing institution	**PRI**

Name	Irrigation based on moisture sensor
Proposing person	Annette Pronk, annette.pronk@wur.nl
Description	Rational irrigation based on the measurements of a moisture sensor instead of based on intuition
Rationale	Crops are sometimes irrigated to much by irrigation based on intuition. Rational irrigation based on a moisture sensor can reduce leaching of water and, therefore, nitrogen.

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	

Crops

x	early potatoes*	x	begonia
x	peas	x	chrysanthemum
x	beans	x	rose tree
x	cauliflower	x	ornamental tree
x	leek	x	tomatoes
x	Brussels sprouts	x	pepper
x	spinach	x	lettuce
x	carrots	x	strawberries
x	onions	x	flower bed/ balcony
x	azalea	x	indoor plant

other crops:

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	x
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Costs for the moisture sensor are quite high

score technical feasibility: 0

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	0

details side effects:

Implementation

Phase: Implemented at <20% of farms

Degree: 1-20%. In horticulture the moisture is nearly daily determined, but mostly 'by hand' and seldom by sensor. Only for strawberries sensors are used because the soil is covered.

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	small (<10%)
P loss reduction:	n/a

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	n/a
Surface groundwater N:	immediately after technique implementation
Surface groundwater P:	n/a

details nutrient loss reduction:	When irrigation is done by intuition overirrigation may happen. Irrigation based on sensor readings and subsequent small applications of water reduce risks on overirrigation and therefore reduce risks of leaching of N. On the other hand, when soils are kept on field capacity by soil mositure sensors and a rain event takes place, leaching will increase compared to situations where soils are kept drier.
Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	The costs of the moisture sensor are quite high, but irrigation is more efficient and cheaper. This can result in a reduction of the costs of 100-200€ (Agrarische Unie).
Global score economic feasibility	-1
Details about the economic feasability	The global costs depend on the crop value. More important is the sensitivity to handel the equipment and the time that is needed to invest in the good functioning of the sensors. Farmers need to spent a lot of time to get it right and to keep it running properly and to adjust irrigation every time over again.
Knowledge gaps	
References	Smit, A., de Ruijter, F. J., de Haan, J. J., and Paauw, J. G. M. 2011. Maatregelen ter vermindering van de nitraatuitspoeling en de mate van toepassing in de praktijk. 2239, Alterra, Wageningen.
National or regional studies	

Code	NL06	Proposing country	The Netherlands	Proposing institution	Plant Research International
Name	Placement of starter P fertilizer in the row or near individual plants				
Proposing person	Frank de Ruijter, Frank.deruijter@wur.nl				
Description	Placement of mineral P fertilizer in the neighbourhood of seeds or young crops				
Rationale	At early stages of growth, phosphorus requirement is high. Placement near the roots can be an effective way to reduce total P application and still have a high concentration near the roots. Placement of 10 or 30 kg P2O5/ha gives similar yields as broadcast application of 200 kg P2O5/ha				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	
P	x

Crops

x	early potatoes*	x	begonia
x	peas	x	chrysanthemum
x	beans	x	rose tree
x	cauliflower	x	ornamental tree
x	leek	x	tomatoes
x	Brussels sprouts	x	pepper
x	spinach	x	lettuce
x	carrots	x	strawberries
x	onions	x	flower bed/ balcony
x	azalea	x	indoor plant

other crops:
crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	x
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Placement takes more time than broadcast application and requires another machine

score technical feasibility: -1
Details technical feasibility: Both are minor bottlenecks

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0
details side effects:	

Implementation

Phase: Ready for field implementation
Degree:
Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	n/a
P use reduction:	very large (>50%)
details nutrient use reduction:	Degree of reduction
N loss reduction:	n/a
P loss reduction:	small (<10%)
details nutrient loss reduction:	Losses of P are mainly linked to total P status of the soil

Effect timing on

Soil N:	n/a
Soil P:	immediately after technique implementation
Surface groundwater N:	n/a
Surface groundwater P:	more than three years after start
details:	Losses of P are mainly linked to total P status of the soil

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Placement takes more time than broadcast application and requires another machine
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	
References	http://www.kennisakker.nl/node/3035 Smit A L, De Willigen P, Pronk A A, 2009. Rapport Plaatsing als strategie voor een efficiëntere fosfaatbemesting - 1. literatuur en modelonderzoek. Wageningen, Plant Research International, Report 216. Ruijter, F.J. de; Smit, A.L.; Meurs, E.J.J., 2009. Plaatsing als strategie voor een efficiëntere fosfaatbemesting : 2.
National or regional studies	

Code	NL07	Proposing country	The Netherlands	Proposing institution	WUR- PPO

Name	Replacing sludge manure by mineral fertilizer
Proposing person	Janjo de Haan, Janjo.deHaan@WUR.NL
Description	Replacing sludge manure by mineral fertilizer or mineral concentrate (from organic manure) at equal effective N dose as mineral fertilizer
Rationale	Sludge manure has a N delivery that can take a long time and that is difficult to manage. By applying organic manure you have to give more total N (and consequently more N susceptible to loss) compared to mineral N. Mineral concentrates can be made out of sludge manure.

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	

Crops

x	early potatoes*		begonia
x	peas		chrysanthemum
x	beans		rose tree
x	cauliflower		ornamental tree
x	leek		tomatoes
x	Brussels sprouts		pepper
x	spinach		lettuce
x	carrots		strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	x
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	x
Increased risk of crop quality reduction	
Legislation	
Other	

Details: More costs due to negative cost of manure sludge, yield reduction after some years observed.

score technical feasibility: -1

Details technical feasibility:

Side effects for

organic carbon	-
weed and/or diseases	0
water use	0
other	-

details side effects:

No reduction in soil activity measured yet in Vredepeel, less nutrients for soil biology

Implementation

Phase: Research phase

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	n/a
details nutrient use reduction:	Less total N use (same effective N dose)
N loss reduction:	average (10-25%)
P loss reduction:	n/a
details nutrient loss reduction:	In groundwater: 100 mg/l instead of 120 mg/l measured

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	n/a
Surface groundwater N:	more than one year after start implementation
Surface groundwater P:	n/a
details:	

Effect crop yield or quality	
Effect:	decrease
Details and timing:	After 6 years decrease in yield at Vredepeel when no manure is applied (reason?)
Costs for investment, production and labour	Costs for less manure application and yield decrease
Global score economic feasibility	-2
Details about the economic feasability	
Knowledge gaps	What is the reason for the decrease in crop yield?
References	Haan, J.J. de; Geel, W.C.A. van; Verstegen, H.A.G.; Hendriks-Goossens, V.J.C. (2010). Nutriënten Waterproof : Nitraatnorm op zand verdraagt geen intensieve landbouw. Wageningen, Praktijkonderzoek Plant & Omgeving B.V., (PPO / rapport) http://edepot.wur.nl/202125
National or regional studies	

Code	NL08	Proposing country	**The Netherlands**	Proposing institution	**Applied Plant Research Wageningen UR**
Name	Soilless cropping				
Proposing person	ir. J.J. de Haan 0320-291211, janjo.dehaan@wur.nl				
Description	Soilles cropping systems in outdoor vegetable crops. Systems should reduce nutrient and pesticide emissions strongly and should be economically viable.				
Rationale	Nutrient emissions in soil bound cropping systems are diffuse and difficult to manage. By creating soilless systems nutrient emissions can be controlled and reduced. Additionnaly, many other advantages can be reached.				

Subsector

- horticulture open air x
- greenhouse horticulture soil
- greenhouse horticulture soilless
- ornamentals soil
- ornamentals soilless

Farming system

- conventional x
- organic

Involved nutrients

- N x
- P x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
x	cauliflower		ornamental tree
x	leek		tomatoes
	Brussels sprouts		pepper
x	spinach	x	lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: other leaf crops

crop yield:

Action domain

- cropping technique x
- crop choice/rotation plan
- fertilisation planning
- fertiliser type x
- fertilisation technique x
- crop residues
- water supply x
- drain water x
- catch crops

Bottlenecks

- Costs x
- Labour intensive
- Knowledge intensive for farmer x
- Knowlegde gaps in research x
- Increased risk of crop yield reduction
- Increased risk of crop quality reduction
- Legislation x
- Other x

Details: Deep flow systems require large investment to start. The systems are still in development. First systems are tested in practice with still various problems to overcome. The new systems are difficult to realize within current spatial planning regulations. Other possible problems are new pests and diseases within the new systemes and societal acceptation.

score technical feasibility: -1

Details technical feasibility: Bottlenecks differ per system and crop. Most important is to get economic feasible systems

Side effects for

- organic carbon 0
- weed and/or diseases +
- water use +
- other +

details side effects:

Less use of pesticides, more efficient land use, larger energy use and greenhouse gas emissions, better labour conditions, larger economical risks

Implementation

Phase: Preliminary field tests

Degree:

Details: First systems are tested on commercial farms

Expected effects on nutrient use and nutrient losses

N use reduction: small (<10%)

P use reduction: small (<10%)

details nutrient use reduction:

Effect timing on

Soil N: n/a

Soil P: n/a

N loss reduction:	very large (>50%)	Surface groundwater N:	n/a
P loss reduction:	very large (>50%)	Surface groundwater P:	n/a
details nutrient loss reduction:	The target is a reduction of more than 50%. This depends also on availability and costs of cleaning techniques.	details:	No measurements are done. Expected is direct effect on N, and slower effect on P because of soil processes.

Effect crop yield or quality

Effect:	increase
Details and timing:	Depends on the crop, in all cases positive effect. Crop yield can increase extremely because of higher planting densities, more cropping periods per year and faster crop growth. This differs between crops. For instance 3-4 croppings of leek are possible with a year production of about 300 ton/ha, this is 5-10 times more than conventional production.
Costs for investment, production and labour	Costs are much higher but yields and financial return is much higher as well. The target is an economically viable system with costs equal or lower compared to conventional systems. It is expected that this is not possible for all systems.
Global score economic feasibility	2
Details about the economic feasability	Costs and returns together
Knowledge gaps	Period of use of recycled water: salt tolerance, control of (new) pest and diseases and control of rainfall excess. Societal acceptance of the systems.
References	see www.teeltdegronduit.nl. Next year the results of the first phase will be reported.
National or regional studies	

Code	NL09	Proposing country	**The Netherlands**	Proposing institution	**WUR- PPO**

Name	Catch crop
Proposing person	Janjo de Haan, Janjo.deHaan@WUR.NL
Description	Planning catch crops after the main crop
Rationale	Crop for capturing the nitrogen in the soil remaining after harvest to minimize N leaching

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

x	early potatoes*		begonia
x	peas		chrysanthemum
x	beans		rose tree
x	cauliflower		ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
x	spinach		lettuce
x	carrots	x	strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops: All crops harvested before 15 september

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	x

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: Early harvest of the main crop is needed, disease risk (nematodes)

score technical feasibility: 1

Details technical feasibility: Nematodes can be a problem

Side effects for

organic carbon	+
weed and/or diseases	0
water use	0
other	+

details side effects:
No extra disease pressure if you choose the catch crop wisely, sometimes less weed pressure (very dependent on crop and situation), higher soil temperature (positive for soil activity), less erosion

Implementation

Phase: Implemented at >20% of farms

Degree: 50

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	n/a
details nutrient use reduction:	Less fertilisation necessary in
N loss reduction:	average (10-25%)
P loss reduction:	n/a
details nutrient loss reduction:	very dependent on crop and situation (0-50%)

Effect timing on

Soil N:	within three months after start implementation
Soil P:	n/a
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	n/a
details:	Depends on the depth of the groundwater

Effect crop yield or quality	
Effect:	no effect
Details and timing:	Over several years: increase soil quality and increase in crop yield/quality
Costs for investment, production and labour	seeds and sowing
Global score economic feasibility	2
Details about the economic feasability	No subsidies in the Netherlands
Knowledge gaps	Resistance for nematodes
References	Haan, Janjo de en Peter Dekker (2005). Best Practices Bemesting Akkerbouw. Praktijkonderzoek Plant & Omgeving. Lelystad. PPO 338-1.
National or regional studies	

Code	NL10	Proposing country	The Netherlands	Proposing institution	WUR- PPO

Name	Fertilization planning
Proposing person	Janjo de Haan, Janjo.deHaan@WUR.NL
Description	Planning of fertilization, mainly focused on N and P
Rationale	Good planning of fertilization and strategy development saves nutrient use, increases nutrient efficiency and decreases losses

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

x	early potatoes*		begonia
x	peas		chrysanthemum
x	beans		rose tree
x	cauliflower		ornamental tree
x	leek		tomatoes
x	Brussels sprouts		pepper
x	spinach	x	lettuce
x	carrots	x	strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops: In principle for all outdoor plants, now focused on vegetables

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	x
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: Attention to fertilization planning in practice is often limited because of low costs of fertilizers compared to crop value and no limitations. However, in the past few years, legislation is becoming more and more a limitation.

score technical feasibility: 1

Details technical feasibility:

Side effects for

organic carbon	+
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase: Implemented at >20% of farms

Degree: Most farmers plan their fertilisation more or less, but in a varying degree

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	average (10-25%)
details nutrient loss reduction:	very dependent on crop and situation (0-50%)

Effect timing on

Soil N:	within three months after start implementation
Soil P:	more than three years after start implementation
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	more than three years after start
details:	Depends on the depth of the ground water

Effect crop yield or quality	
Effect:	increase
Details and timing:	With a good planning a positive effect on crop yield and quality can be expected
Costs for investment, production and labour	Costs for advice for planning
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	
References	Kroonen, B.M.A. & J.J. de Haan (2005). Een goed stikstofbeheer is geld waard, Preiteler, haal meer stikstof uit de bodem! Brochure bemesting in prei tbv prei-demo Vredepeel 28 oktober 2005. Praktijkonderzoek Plant & Omgeving. Vredepeel. X
National or regional studies	

Code	NL11	Proposing country	The Netherlands	Proposing institution	Plant Research International
Name	Placement of starter N fertilizer in the row or near individual plants				
Proposing person	Frank de Ruijter, Frank.deruijter@wur.nl				
Description	Placement of mineral N fertilizer in the neighbourhood of newly planted vegetables				
Rationale	Vegetables can profit of a high N availability in the soil at planting. To reduce the risk of leaching in the first weeks after planting, N is applied only in the vicinity of plants at planting, and additional N is fertilized after a number of weeks after planting. This reduces the risk of leaching without changing the N availability for the crop.				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans	x	rose tree
x	cauliflower	x	ornamental tree
x	leek		tomatoes
x	Brussels sprouts		pepper
	spinach	x	lettuce
	carrots	x	strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: Tests have been done with endive

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	x
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Placement takes more time than broadcast applicationand requires an other machine

score technical feasibility: -1

Details technical feasibility: Both are minor bottlenecks

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase: Ready for field implementation

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)
P use reduction:	n/a
details nutrient use reduction:	See also NL06
N loss reduction:	small (<10%)
P loss reduction:	n/a
details nutrient loss reduction:	

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	n/a
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	n/a
details:	This depends on time of application in the year relative to the leaching period, and the depth of the groundwater table

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Placement takes more time than broadcast application and requires an other machine
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	The technique may be studied or demonstrated for other crops, and may be repeated to know the effect over a number of years
References	De Ruijter, F J 2007 Stikstofbemesting bij andijvie. Timing (start, bijbemesting) en plaatsing (plant, rij, bed). Wageningen, Plant Research International. Report 164, 21 pp (http://edepot.wur.nl/26298) De Ruijter, F J 2009 Andijvie doet het goed op 'gedeelde' stikstof. Groenten en Fruit 2009 (11): 32 - 33 (http://edepot.wur.nl/11746)
National or regional studies	

Code	NL12	Proposing country	The Netherlands	Proposing institution	WUR-PPO Randwijk Nursery stock
Name	Soilless cultivation of nursery stock crops - U system				
Proposing person	Henk van Reuler				
Description	Soilless cropping systems in outdoor tree nurseries. Systems should reduce nutrient and pesticide emissions strongly and should be economically viable.				
Rationale	Nutrient emissions in soil bound cropping systems are diffuse and difficult to manage. By creating soilless systems nutrient emissions can be controlled and reduced. In addition, many other advantages can be reached.				

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	x

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

early potatoes*	begonia
peas	chrysanthemum
beans	rose tree
cauliflower	ornamental tree
leek	tomatoes
Brussels sprouts	pepper
spinach	lettuce
carrots	strawberries
onions	flower bed/ balcony
azalea	indoor plant

other crops: nursery stock crops (a.o. street trees, shrubs)
crop yield:

Action domain

cropping technique	x
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 0
Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	-
other	+

details side effects:
Easier harvest, better product quality (roots)

Implementation

Phase: Implemented at <20% of farms
Degree: <10%
Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	average (10-25%)
details nutrient use reduction:	
N loss reduction:	very large (>50%)
P loss reduction:	very large (>50%)
details nutrient loss reduction:	Closed system, no losses

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	immediately after technique implementation
Surface groundwater N:	immediately after technique implementation
Surface groundwater P:	immediately after technique implementation
details:	

Effect crop yield or quality

Effect: increase
Details and timing: Better root properties for selling the trees, higher productivity/ha

Costs for investment, production and labour	Investment cost: 30 euro per meter construction
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	Ongoing research - quantification of nutrient and water use efficiencies, crop diversification, economic data
References	
National or regional studies	

Code	NL13	Proposing country	**The Netherlands**	Proposing institution	**WUR-PPO Randwijk Nursery stock**
Name	pot-in-pot cropping system				
Proposing person	Henk van Reuler				
Description	The pot-in-pot system is a soilless culture growing system based on a closed system of pots connected with tubes in the subsoil. The pots are place in the soil. This in contrast with the common pot-in-pot system where the pots are placed on the soil surface.				
Rationale	The pot-in-pot system has been developed already some years ago. The system was never implemented at a large scale in the Netherlands. The new legislation requires minimal emission of nutrients and crop protection chemicals. This combined with a new tools for constructing the field explains the interest in this system. The technique is developed and tested in close cooperation with growers.				

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	x

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

early potatoes*	begonia
peas	chrysanthemum
beans	rose tree
cauliflower	ornamental tree
leek	tomatoes
Brussels sprouts	pepper
spinach	lettuce
carrots	strawberries
onions	flower bed/ balcony
azalea	indoor plant

other crops:
crop yield:

Action domain

cropping technique	x
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Rather fixed system configuration, not flexible to be moved or adapted (e.g. container size)

score technical feasibility: 0
Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	+
water use	-
other	+

details side effects:
Easier harvest

Implementation

Phase: Ready for field implementation
Degree:
Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	average (10-25%)
details nutrient use reduction:	
N loss reduction:	very large (>50%)
P loss reduction:	very large (>50%)
details nutrient loss reduction:	Closed system, no losses

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	immediately after technique implementation
Surface groundwater N:	immediately after technique implementation
Surface groundwater P:	immediately after technique implementation
details:	

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	investment cost (estimation): € 20/m2
Global score economic feasibility	
Details about the economic feasability	depends on the specific farm conditions
Knowledge gaps	ongoing research - quantification of nutrient and water use efficiencies, crop diversification, economic data
References	
National or regional studies	

Code	NL14	Proposing country	**The Netherlands**	Proposing institution	**BLGG**

Name	Scientific base for N fertilization recommendation
Proposing person	Arjan Reijneveld, Arjan.Reijneveld@blgg.nl and Gerard Ros
Description	Estimation of the N delivery capacity of the soil, based on a model including organic matter quantity and quality and weather influences
Rationale	Taking the N delivery capacity of the soil into account, one can reduce the N fertilization recommendation and N gift, thereby reducing the N losses

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

x	early potatoes*		begonia
x	peas		chrysanthemum
x	beans		rose tree
x	cauliflower		ornamental tree
x	leek		tomatoes
x	Brussels sprouts		pepper
x	spinach		lettuce
x	carrots		strawberries
x	onions		flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield: n/a

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Validation of horticulture cropping systems need to be done; model is validated on grass and major arable crops yet

score technical feasibility: 0

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0
details side effects:	

Implementation

Phase: Ready for field implementation

Degree:

Details: needs adaptation for regional conditions

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	n/a
details nutrient use reduction:	effect is crop dependent
N loss reduction:	large (25-50%)
P loss reduction:	n/a
details nutrient loss reduction:	Effect is crop dependent

Effect timing on

Soil N:	within three months after start implementation
Soil P:	n/a
Surface groundwater N:	within three months after start implementation
Surface groundwater P:	n/a
details:	Time is part of the dynamic N-recommendation advice, so it can be applied during the whole season depending on fertilizer possibilities

Effect crop yield or quality	
Effect:	increase
Details and timing:	Crop dependent, but e.g. grass quality increase seems possible, probably also for other crops?
Costs for investment, production and labour	No specific costs (website application)
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	Calibration for more crops; potential combination with dynamic fertilizer schemes (work in progress)
References	PhD thesis Ros (2011) and div. publications of Ros et al. (2012)
National or regional studies	Further testing, validation and implementation under Dutch conditions is work in progress

Code	NL15	Proposing country	**The Netherlands**	Proposing institution	**BLGG**
Name	Scientific base for P fertilization recommendation				
Proposing person	Arjan Reijneveld, Arjan.Reijneveld@blgg.nl, Wim Bussink and Debby van Rotterdam-Los				
Description	Determination of the P intensity, P quantity and P buffering capacity of a soil in order to give rational, scientific based P fertilization recommendation				
Rationale	Sound P fertilization requires good estimations of the P availability for plants in a soil. The P availability can be well estimated by determination of the P quantity (P-AL), P intensity (P-CaCl2) and P- buffering capacity (from the desorption isotherm)				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	
P	x

Crops

early potatoes*	begonia
peas	chrysanthemum
beans	rose tree
cauliflower	ornamental tree
leek	tomatoes
Brussels sprouts	pepper
spinach	lettuce
carrots	strawberries
onions	flower bed/ balcony
azalea	indoor plant

other crops: all soil crops

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 2

Details technical feasibility:

Side effects for

organic carbon	-
weed and/or diseases	0
water use	0
other	0

details side effects:
Better allocation of soils who really need P, less organic carbon if less organic manure is applied

Implementation

Phase: Implemented at <20% of farms

Degree: Dairy farming, to a certain extent in arable farming

Details: Additional P trials will follow

Expected effects on nutrient use and nutrient losses

N use reduction:	n/a
P use reduction:	average (10-25%)
details nutrient use reduction:	It can vary between -70 and +30
N loss reduction:	n/a
P loss reduction:	small (<10%)
details nutrient loss reduction:	Difficult to say, no experiments in that direction yet

Effect timing on

Soil N:	n/a
Soil P:	between one and three years after start implementation
Surface groundwater N:	n/a
Surface groundwater P:	more than three years after start
details:	

Effect crop yield or quality	
Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Depending on lab procedures, at BLGG almost none due to the concept of multinutrient extraction
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	Application for vegetables in open soil
References	van Rotterdam-Los, A. M. D 2010. The potential of soils to supply phosphorus and potassium: processes and predictions. Wageningen University, Wageningen. Bussink, D. W., Bakker, R. F., van der Draai, H., & Temminghoff, E. J. M. 2011a. Naar een advies voor fosfaatbemesting op nieuwe leest; deel 1 snijmaïs. 1246.1, Nutriënten Management Instituut NMI B.V., Wageningen. Bussink, D. W., Bakker, R. F., van der Draai, H., & Temminghoff, E. J. M. 2011b. Naar een advies voor fosfaatbemesting op nieuwe leest; deel 2 grasland. Nutriënten Management Instituut NMI B.V., Wageningen.
National or regional studies	

Code	NL16	Proposing country	**The Netherlands**	Proposing institution	**WUR Glastuinbouw**

Name	Emission management system using lysimeter, moisture sensor, model, software
Proposing person	Wim Voogt, wim.voogt@wur.nl
Description	The method consists of three modules: lysimeter, soil moisture sensors and models
Rationale	Knowledge and insight for the farmer about the water cycle, in order to adjust irrgation to crop demand

Subsector

horticulture open air	
greenhouse horticulture soil	x
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas	x	chrysanthemum
x	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts	x	pepper
x	spinach	x	lettuce
	carrots	x	strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: bulb flower crops, cut flowers

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	
water supply	x
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 0

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	0

details side effects:
The farmer gathers extra information

Implementation

Phase: Ready for field implementation

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	small (<10%)
details nutrient use reduction:	depending on initial use
N loss reduction:	very large (>50%)
P loss reduction:	small (<10%)
details nutrient loss reduction:	depending on initial use

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	immediately after technique implementation
Surface groundwater N:	immediately after technique implementation
Surface groundwater P:	immediately after technique implementation
details:	

Effect crop yield or quality

Effect: no effect

Details and timing:

Costs for investment, production and labour	Investment: 10000 euro for installation (1500 yearly)
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	calibration soil moisture sensors, behaviour soil moisture sensors, behaviour of N in lysimeters: representative?, how much can the water gift be reduced without problems
References	Voogt, W. (2013) Rapport: Ontwikkeling emissiemanagementsysteem grondgebonden teelt; lysimeter en drainmeter
National or regional studies	

Code	NL17	Proposing country	**The Netherlands**	Proposing institution	**WUR Glastuinbouw**

Name	waterstreams
Proposing person	Wim Voogt, wim.voogt@wur.nl
Description	The model quantifies the water input and output waterflows of a greenhouse, based on variables of the wheather and greenhouse climate and some crop and technical parameters. Output can be used in several ways: in the long term irrigation and drainage strategy; the decision making for discharge; the decision on investments for optimal use of the available water resources or means for supplement
Rationale	A detailed description can be found in: Voogt, W.; Swinkels, G.L.A.M.; Os, E.A. van (2012). 'Waterstreams': A model for estimation of crop water demand, water supply, salt accumulation and discharge for soilless crops. Acta Horticulturae, 957 , 123 - 130.

Subsector

horticulture open air	
greenhouse horticulture soil	x
greenhouse horticulture soilless	x
ornamentals soil	x
ornamentals soilless	x

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas	x	chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts	x	pepper
	spinach	x	lettuce
	carrots	x	strawberries
	onions		flower bed/ balcony
	azalea	x	indoor plant

other crops: cucumber, melons, hippeastrum, fresia, gerbera, lily, cut flowers, bulb crops

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	
water supply	x
drain water	x
catch crops	

Bottlenecks

Costs	
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: Models needs calibration and parametrisation

score technical feasibility: -1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	+

details side effects:

The total water use can be reduced, by optimization of the use of the available resources. The costs for water can be reduced by making strategic decisions

Implementation

Phase: Research phase

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	n/a
P use reduction:	n/a
details nutrient use reduction:	

Effect timing on

Soil N:	n/a
Soil P:	n/a

N loss reduction:	large (25-50%)	Surface groundwater N:	between three months and one year after start
P loss reduction:	large (25-50%)	Surface groundwater P:	between one and three years after start
details nutrient loss reduction:	Calculations were made based on datasets from greenhouse growers, where virtually the N losses could be reduced to zero	details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Initally 1000€ per case. Growers can subscribe for additional runs, yearly costs approx 500€
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	A lot of gaps, related to specific parameters for a number of crops; calibration and validation
References	Bezemer, J.; Voogt, W. (2008). Elke kuub water van bron tot sloot in beeld gebracht (interview met Wim Voogt) - Met nieuw rekenmodel kan teler zijn watermanagement optimaliseren Onder Glas 5 (2). - p. 46 - 47. Voogt, W.; Os, E.A. van (2010)
National or regional studies	

Code	NL18	Proposing country	The Netherlands	Proposing institution	WUR Glastuinbouw

Name: Advanced oxidation

Proposing person: Wim Voogt, wim.voogt@wur.nl

Description: This method is ment to 'detoxify' the recirculating water. It consists of an UV-treatment in combination with oxidation by using hydrogenperoxide or ozone. Using this method, the grower will postpone the discharge from the system.

Rationale: Companies with soilless culture systems need to close the water cycle. Research has been executed to determine the technical and economic prospects to purify discharge water. Advanced oxidation of plant protection products and also organic compounds causing growth reduction has high potential.

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	x

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts	x	pepper
	spinach	x	lettuce
	carrots	x	strawberries
	onions		flower bed/ balcony
	azalea	x	indoor plant

other crops: all soilless grown crops

crop yield:

Action domain

cropping technique	x
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	
water supply	
drain water	x
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	+

details side effects:
Reduces water use (higher water efficiency), lower risk for growth reduction caused by long recirculation. Reduction of leaching of pesticides.

Implementation

Phase: Preliminary field tests

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)
P use reduction:	small (<10%)
details nutrient use reduction:	
N loss reduction:	very large (>50%)
P loss reduction:	very large (>50%)

Effect timing on

Soil N:	n/a
Soil P:	n/a
Surface groundwater N:	immediately after technique implementation
Surface groundwater P:	immediately after technique implementation

details nutrient loss reduction:	The system wil reduce discharge of drainage water, which is necessary for preventing growth reduction.

Effect crop yield or quality

Effect:	increase
Details and timing:	The method minimizes risks of growth reduction.
Costs for investment, production and labour	investment 10 000€, yearly costs < 1000€ per unit
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	Long term effect. Effects on nutrients (Fe-chelates).
References	Arkesteijn, M.; Os, E.A. van (2012) Waterstofperoxide en UV-ontsmetter werken samen extra effectief (interview met o.a. Erik van Os) Onder Glas 9 (10). - p. 16 - 17. Os, E.A. van; Maas, A.A. van der; Meijer, R.J.M.; Khodabaks, M.R.; Blok, C.; Enthoven, N.L.M. (2012) Advanced oxidation to eliminate growth inhibition and to degrade plant protection products in a recirculating nutrient solution in Rose cultivation In: ISHS 28th Int. Horticultural Congress - Science and Horticulture for People (IHC 2010): International Symposium on Greenhouse 2010 and Soilless Cultivation. - Acta Horticulturae 927 . - p. 941 - 947.Lisbon, Portugal : ISHS, - p. 941 - 947. ISHS 28th Int. Horticultural Congress - Science and Horticulture for People (IHC 2010): International Symposium on Greenhouse 2010 and Soilless Cultivation, 2010-08-22/ 2010-08-27
National or regional studies	

Code	NL19	Proposing country	The Netherlands	Proposing institution	WUR Glastuinbouw

Name	Membrane destillation, elektrodialysis and capacitive de-ionisation
Proposing person	Wim Voogt, wim.voogt@wur.nl
Description	Innovative techniques, able to remove salts and nutrients for water, either specifically or general
Rationale	These methods will remove ions from drainage water from closed growing systems, in case of accumulation of these elements, which involves that the grower will postpone the moment of necessary discharge of drainage water

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	x

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts	x	pepper
	spinach	x	lettuce
	carrots	x	strawberries
	onions		flower bed/ balcony
	azalea	x	indoor plant

other crops: all soilless grown crops
crop yield:

Action domain

cropping technique	x
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	x
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	x

Details: Methods are innovative techniques and not yet fully developed

score technical feasibility: -2
Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	0

details side effects:

Implementation

Phase: Research phase
Degree:
Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)
P use reduction:	small (<10%)
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	average (10-25%)
details nutrient loss reduction:	This is only applicable for salt sensitive crops and those farms where the water quality is a bottleneck

Effect timing on

Soil N:	n/a
Soil P:	n/a
Surface groundwater N:	within three months after start implementation
Surface groundwater P:	within one year after start implementation

Effect crop yield or quality

Effect: no effect
Details and timing:

Costs for investment, production and labour	Costs not know yet, but probably relatively high compared to other operational costs for water treatment
Global score economic feasibility	?
Details about the economic feasability	unknown yet
Knowledge gaps	Technical feasability
References	In press
National or regional studies	

Code	NL20	Proposing country	The Netherlands	Proposing institution	Stichting Proeftuin Zwaagdijk
Name	Floating cultivation				
Proposing person	Matthijs Blind, Tolweg 13, NL-1681 ND Zwaagdijk-Oost, matthijsblind@proeftuinzwaagdijk.nl				
Description	Deep Flow Technique. Plants are grown in a nutrient solution in tanks/basins with a water depth which varies approximately between 15-35 cm. Plants are fixed in (e.g. polystyrene) floats and develop their roots almost entirely in a nutrient solution. The nutrient solution is circulating and aerated permanently.				
Rationale	Nutrient emissions in soil bound cropping systems are diffuse and difficult to manage. By creating soilless systems nutrient emissions can be controlled and reduced. Besides many other advantages can be reached.				

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
x	cauliflower		ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
x	spinach	x	lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: Several cutflowers

crop yield: Lettuce (type butter head) , about 82,000 heads/ha.crop, 4-5 crops/year

Action domain

cropping technique	x
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	x
catch crops	

Bottlenecks

Costs	x
Labour intensive	x
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	x
Increased risk of crop quality reduction	x
Legislation	x
Other	

Details:

score technical feasibility: -1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	0

details side effects:
lower water use

Implementation

Phase: Implemented at <20% of farms

Degree: <1%

Details: System is tested/implemented on small scale by a couple of growers

Expected effects on nutrient use and nutrient losses

N use reduction: very large (>50%)

P use reduction: n/a

details nutrient use reduction: P: difficult to answer because of legislation and high concentration in soils

Effect timing on

Soil N: immediately after technique implementation

Soil P: immediately after technique implementation

N loss reduction:	very large (>50%)	Surface groundwater N:	immediately after technique implementation
P loss reduction:	n/a	Surface groundwater P:	immediately after technique implementation
details nutrient loss reduction:	P: high if loss of P from saturated soils are taken into account	details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	It can be expected that if the system is optimized the crop quality will increase
Costs for investment, production and labour	The cost of the investment is expected to be about 50 €/m2. It is also expected that if applied on larger scale the production and labour costs will decrease due to mechanisation.
Global score economic feasibility	-2
Details about the economic feasability	
Knowledge gaps	Disease development , nutrition, growing media for sowing. Optimum circulation and aeration
References	‘Demo teelt sla op teeltsystemen in de vollegrond (2007)’ (PT 12930), december 2007. ‘Alternatieve teeltsystemen voor de vollegrondsgroententeelt 2008-2010’ (PT 13183), maart 2011.
National or regional studies	

Code	SP01	Proposing country	Spain	Proposing institution	**University of Almeria / Primaflor**

Name	Enviroscan (+Triscan)
Proposing person	Rodney Thompson / Antonio Marhuenda
Description	EnviroSCAN is a soil moisture sensor, based on frequency readings in the soil. Using a default calibration equation it gives data in volumetric water content (mm of water per 100 mm of soil measured). It needs in situ calibration. The TriSCAN sensor provides measurements of both soil water and salinity.
Rationale	By creating a high frequency electrical field around the sensor, extending through the access tube into the surrounding soil, the sensors detect the changes in dielectric constant, or permittivity, of the soil over time. At high frequency the measurement is affected predominantly by water molecules. The greater the amount of water, the smaller the frequency measured between the two brass rings of the sensor. The TriSCAN sensor provides measurements of both soil water and salinity and is able to distinguish between soil water content and salt content. A model from Sentek is available to calculate soil volumetric ion content (VIC) separately from the Volumetric Water Content.

Subsector

horticulture open air	x
greenhouse horticulture soil	x
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
x	beans		rose tree
x	cauliflower		ornamental tree
x	leek	x	tomatoes
	Brussels sprouts		pepper
x	spinach	x	lettuce
	carrots	x	strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: All crops fertigated with T-tape (strawberries, zucchini, ..)

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	
water supply	x
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	x
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	+

details side effects:

other = avoids percolation of water and nutrients

Implementation

Phase: Implemented at <20% of farms

Degree: 10 farms of 15,000 farms

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	small (<10%)
details nutrient use reduction:	no percolation

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	immediately after technique implementation

N loss reduction:	very large (>50%)	Surface groundwater N:	immediately after technique implementation
P loss reduction:	small (<10%)	Surface groundwater P:	immediately after technique implementation
details nutrient loss reduction:	no percolation	details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	
Costs for investment, production and labour	Sensors, irrigationmodel and automatisation
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	
References	8. Thompson, R.B., Gallardo, M., Fernández, M.D., Valdez, L.C., Martínez-Gaitán, C. 2007. Effect of salinity on soil moisture measurements made with a capacitance sensor under vegetable production conditions. Soil Science Society of America Journal, 71: 1647–1657.
National or regional studies	

Code	SP05	Proposing country	Spain	Proposing institution	University of Almeria

Name	Simulation model of daily crop growth, nutrient uptake and evapotranspiration (Vegsyst)
Proposing person	R.B Thompson
Description	Vegsyst is a simulation model of daily crop growth, nutrient uptake and evapotranspiration to be used by on-farm decision making support system. This model model requires the input of daily climatic data. It was developed for greenhouse-grown vegetable crops; is being adapted to open field crops.
Rationale	The dry matter production, crop N uptake and crop evapotranspiration are simulated on a daily basis. The dry matter production is calculated from daily fraction of intercepted photosynthetically active radiation, PAR radiation and radiation use efficiency. The fraction of intercepted PAR is calculated from relative thermal time. The crop N uptake is calculated as the product of dry matter production and N content. The crop evapotranspiration is the product of daily reference evapotranspiration using an adapted Penman-Montheith equation and a daily simulated crop coefficient value.

Subsector

horticulture open air	
greenhouse horticulture soil	x
greenhouse horticulture soilless	x
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower		ornamental tree
	leek	x	tomatoes
	Brussels sprouts	x	pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops: melon

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	
fertilisation technique	x
crop residues	
water supply	x
drain water	x
catch crops	

Bottlenecks

Costs	
Labour intensive	x
Knowledge intensive for farmer	x
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: 1) Currently, is calibrated for pepper, melon and tomato. Will be adapted to the other major species in this system. 2) Has been incorporated into prototype decision support system (DSS). DSS requires development of practical software and calibration of more species.

score technical feasibility: 1

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	+
other	+

details side effects:

other = salinity

Implementation

Phase: Research phase

Degree:

Details: The model is relatively easy to use. However, the DSS that incorporates the model requires further development and the farmers in Almeria Spain at the moment don't feel the need to use this

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)	**Effect timing on**	
P use reduction:	n/a	Soil N:	immediately after technique implementation
details nutrient use reduction:		Soil P:	n/a
N loss reduction:	large (25-50%)	Surface groundwater N:	immediately after technique implementation
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:	Reducing both excessive irrigation and N application can result in appreciable reduction in NO3 leaching loss, see Granados et al (2013) Agric Water Manage. 119:121-134		

Effect crop yield or quality

Effect:	no effect
Details and timing:	

Costs for investment, production and labour	Measuring temperature, relative humidity and solar radiation, use of the model….Note: average climatic data can be used
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	The decision support system (DSS) based on VegSyst requires values for (a) N mineralisation for manure and soil organic matter, and for (b) efficiencies of crop uptake of N applied by fertigation and of N mineralised from manure and soil OM. Currently, these values are mostly simple estimates. Experimentally determined values would enhance accuracy.
References	1) Gallardo M, Gimenez C, Martinez-Gaitan C, Stockle CO, Thompson RB, Granados MR (2011) Evaluation of the VegSyst model with muskmelon to simulate crop growth, nitrogen uptake and evapotranspiration. Agricultural Water Management 101 (1):107-117. doi:10.1016/j.agwat.2011.09.008
National or regional studies	

Code	WA01	Proposing country	**Belgium (Walloon region)**	Proposing institution	**CRA-W Gembloux**

Name	Use of a recommendation program for the fertilisation planning
Proposing person	Jean-Pierre Goffart, goffart@cra.wallonie.be; Morgan Abras, m.abras@cra.wallonie.be
Description	Establishment of a N fertilization recommendation based on a provisional N balance sheet method at specific field scale. It assumes a balance between crop N needs and N supply from soil and fertilizers. It requires acquisition of a set of specific data from each field, related to the features of the soil (soil texture, carbon rate, mineral N rate of the profile in layer of 0 to 60 cm at the set up of the crop) and to the husbandry history of the field (previous crop, organic amendments, establishment of a green manure, fate of crop residues, ...) which are considered to estimate soil mineral N supply during the growing season). The method is applicable for several crops, but was validated specifically in Wallonia for carrots (Daucus carota), escarole (Cichorium endivia var. latifolia), Welsh onion (Allium fistulosum), beans and curled-leaved endive (Cichorium endivia var. crispa).
Rationale	The fertilization recommendations was basically established with the Azobil method developed by INRA (Laon, France) which has been parametered for the Walloon conditions. N needs were refined for different crops based on N field experiments conducted in Wallonia (carrots, escarole, welsh onion, curled-leaved endive, beans). N needs are set at a flat rate for each crop. They aim to supply the N requirements leading to maximal potential yield of the crop in their optimal conditions of development and growth. Soil mineral N stock at sowing or transplanting are measured from soil samples taken in the 0-60 cm soil layer. Other balance sheet parameters, such as net mineralization during cultivation or potential N losses through leaching were estimated a priori by Azobil based on the information provided.

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*	begonia
	peas	chrysanthemum
x	beans	rose tree
	cauliflower	ornamental tree
	leek	tomatoes
	Brussels sprouts	pepper
x	spinach	lettuce
x	carrots	strawberries
x	onions	flower bed/ balcony
	azalea	indoor plant

other crops: escarole, welsh onion, curled-leave endive

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	x
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

Side effects for

organic carbon: 0

weed and/or diseases: 0

water use: 0

other: 0

details side effects:

score technical feasibility: 1

Details technical feasibility: Need for soil sampling and analysis of N before sowing and planting, together with information to be collected on field history and characteristics

Implementation

Phase: Implemented at <20% of farms

Degree: Farms using the recommendation program apply it for approximately 50% of the crops

Details:

Expected effects on nutrient use and nutrient losses

N use reduction: large (25-50%)

P use reduction: n/a

details nutrient use reduction:

N loss reduction: average (10-25%)

P loss reduction: n/a

details nutrient loss reduction:

Effect timing on

Soil N: within three months after start implementation

Soil P: n/a

Surface groundwater N: between three months and one year after start

Surface groundwater P: n/a

details:

Effect crop yield or quality

Effect: no effect

Details and timing:

Costs for investment, production and labour	no extra costs
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	It is generally applied for vegetables for the industry. Knowledge gap: mineralisation in the field and accurate crop N needs.
References	M. Abras, J.P. Goffart, S. Renard, J.P. Destain, 2012. Management of Nitrogen Fertilization of fresh vegetable crops at field scale in the Walloon region of Belgium. Acta Hort., 938, 235-142. ; Renard S, Goffart JP and Frankinet M. (2009). Nitrogen fertilization for spinach-bean rotations; Proceedings of the 1 st International Symposium on Horticulture in Europe (Dixon GR eds). Acta Horticulturae, 817: 251-258
National or regional studies	

Code	WA02	Proposing country	**Belgium (Walloon region)**	Proposing institution	**CRA-W Gembloux**

Name	Management of intercropping period after vegetables crops to reduce N losses through leaching
Proposing person	Jean-Pierre Goffart, goffart@cra.wallonie.be; Morgan Abras, m.abras@cra.wallonie.be; s.renard@c
Description	Catch crops (rye and rye-grass) are sown following vegetable crops (spinach-bean; spinach-spinach succession) that are harvested late autumn. Rye and rye-grass are sown up to 15th of October and ploughed next year in January-February. This technique leads to considerable N reduction in the 1.5m soil profile (up to 80 kg N ha-1) due to rye cover compared to bare soil in march of following year. The planting date is decisive for mineral N recovery of catch crops.
Rationale	Vegetables crops are generally characterized by a short growing cycle (three to four months) and a shallow roots development: 0-30 cm for bean and 0-15 cm for spinach . This increases their sensitivity to water and N availability in soil and leads to variable yields. Moreover there is a lack of knowledge about N crop needs as well as the mineral pool of N from farm manures and crop residues, therefore unbalanced N application rates are often applied (European Community Network ENVEG, Concerted Action 1998-2000). The most frequent vegetable successions in the Hesbaye area are broad bean (Vicia faba L., Fabaceae) - autumnal spinach or spring spinach - bean. Growing two succeeding crops with high N requirements, such as spinach within a same year, makes it more difficult to manage N fertilization and particular attention must be paid to the contribution of crop residues which vary according to local pedo-climatic conditions and the type of residue . This leads to problems at harvest of the vegetable crops in relation to yield and quality (nitrate concentration, bean size), and produces environmental hazards due to nitrate leaching and fertiliser management of subsequent crops. Correct management of the inter-cropping period after vegetable production may reduce leaching during the drainage period. Rye (Secale cereale L.) is well adapted, particularly for sowing as a late cover crop: compared to bare soil, a higher reduction of soil mineral nitrogen is measured after rye than after rye-grass.

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*	begonia
	peas	chrysanthemum
x	beans	rose tree
	cauliflower	ornamental tree
	leek	tomatoes
	Brussels sprouts	pepper
x	spinach	lettuce
	carrots	strawberries
	onions	flower bed/ balcony
	azalea	indoor plant

other crops:

crop yield:

Action domain

cropping technique	x
crop choice/rotation plan	x
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	x

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	
Details:	cost for seeds and sowing

Side effects for			
organic carbon	+	score technical feasibility:	2
weed and/or diseases	+	Details technical feasibility:	highly feasible
water use	-	**Implementation**	
other	0	Phase:	Ready for field implementation
details side effects:		Degree:	
		Details:	

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)	**Effect timing on**	
P use reduction:	n/a	Soil N:	immediately after technique implementation
details nutrient use reduction:	nutrient use reduction	Soil P:	n/a
N loss reduction:	large (25-50%)	Surface groundwater N:	more than one year after start implementation
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:	up to 80 kg N ha-1 can be saved from leaching in autumn	details:	

Effect crop yield or quality

Effect:	no effect
Details and timing:	no effect on subsequent crop (either vegetable or others)
Costs for investment, production and labour	no specific costs except for catch crops seeds and sowing
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	effect of rye sowing date should be studied further
References	Nitrogen fertilization for spinach-bean rotations - A case study on loamy soils in Belgium
National or regional studies	

Code	WA03	Proposing country	**Belgium (Walloon region)**	Proposing institution	**CRA-W Gembloux**

Name: Split the N dose for a higher efficiency

Proposing person: Jean-Pierre Goffart, goffart@cra.wallonie.be; Morgan Abras, m.abras@cra.wallonie.be

Description: N splitting for four crops : carrot (Daucus carota), escarole (Cichorium endivia var latifolia), Welsh onion (Allium fistulosum) and curled-leave endive (Cichorium endivia var. crispa) experimented in Wallonia. The application of splitted N-dosis corresponds to periods of highest N-uptake expressed in days after sowing or transplanting.

Rationale: Splitting shows little or no significant effects on yield and N use efficiency for carrots, escarole and welsh onion. Higher yields and N use efficiency are expected for curled leave endive. On the other hand, for escarole, welsh onion and curled leaved endive soil mineral N residues are generaly significantly reduced at harvest

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	

Crops

	early potatoes*	begonia
	peas	chrysanthemum
	beans	rose tree
	cauliflower	ornamental tree
	leek	tomatoes
	Brussels sprouts	pepper
	spinach	lettuce
x	carrots	strawberries
x	onions	flower bed/ balcony
	azalea	indoor plant

other crops: carrots, welsh onion, escarole, curled leave endive

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	x
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	
Labour intensive	x
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 2

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase: Preliminary field tests

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	small (<10%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	n/a
details nutrient loss reduction:	

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	n/a
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	n/a
details:	From some months to several years (according to the depth of the groundwater table)

Effect crop yield or quality

Effect:	increase
Details and timing:	Small but not significant yield increase, some decrease in plant nitrate concentration
Costs for investment, production and labour	No specific costs, except for the second N application
Global score economic feasibility	2
Details about the economic feasability	
Knowledge gaps	No, it is an arbitrary system
References	M. Abras, S. Renard, J.P. Goffart, 2011. Gestion de la fertilisation azotée des légumes destinés au marché du frais en Wallonie (Belgique) - Evolution du statut azoté des cultures et fractionnement des apports. Rapport de projet de recherche CRA-W. ; Abras M , Baeten V and Goffart JP (2013). Management of nitrogen fertilization of fresh vegetable crops at field scale in Wallonia (Belgium); Splitting of nitrogen fertilizer applications and monitoring of crop nitrogen status (this Symposium).
National or regional studies	

Code	WA04	Proposing country	**Belgium (Walloon region)**	Proposing institution	**CRA-W Gembloux**

Name	Determine the level of the additional mineral dressing by use of crop determinations
Proposing person	Jean-Pierre Goffart, goffart@cra.wallonie.be; Morgan Abras, m.abras@cra.wallonie.be
Description	Follow-up of crop N status (CNS) and decision on the need to appy additional N. For Welsh onion, the CNS is assessed through leaf nitrate content measurements (using test strips and Nitrachek reflectometer). Threshold value of 2200 ppm (+/- 5%) has been proposed for the period ranging from 40 to 52 days after sowing. For curled-leaved endive, the CNS can be estimated either through leaf nitrate content measurements or through a chlorophyll meter (Hydro N-tester, Yara, Norway). For the nitrate test, threshold values of 2150 ppm (+/- 5%) and 2270 ppm (+/- 5%) have been proposed respectively for the periods ranging from 24 to 31 days after planting and from 33 to 40 days after planting. Similar threshold values for the chlorophyll meter are respectively for both periods 453 and 478.
Rationale	This approach needs to be combined with a recommendation N rate method, and also with the splitting of mineral N fertilizer. A recommendation N rate is firstly calculated based on the balance sheet method Azobil. Only part of the recommended rate is applied at planting (for instance 50 or 70% is applied, still to be determined). The remaining N is applied when the threshold value of the indicator of CNS is reached, the crop being considered as the best indicator of its own N needs. The aim is to increase N efficiency by better matching N needs and supply during the growing season.

Subsector

horticulture open air	x
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	
ornamentals soilless	

Farming system

conventional	x
organic	

Involved nutrients

N	x
P	

Crops

	early potatoes*	begonia
	peas	chrysanthemum
	beans	rose tree
	cauliflower	ornamental tree
	leek	tomatoes
	Brussels sprouts	pepper
	spinach	lettuce
	carrots	strawberries
x	onions	flower bed/ balcony
	azalea	indoor plant

other crops: welsh onion and curled-leaved endive

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	x
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details:

score technical feasibility: 0

Details technical feasibility:

Side effects for

organic carbon	0
weed and/or diseases	0
water use	0
other	0

details side effects:

Implementation

Phase: Preliminary field tests

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	average (10-25%)
P use reduction:	n/a
details nutrient use reduction:	
N loss reduction:	average (10-25%)
P loss reduction:	n/a
details nutrient loss reduction:	

Effect timing on

Soil N:	immediately after technique implementation
Soil P:	n/a
Surface groundwater N:	between three months and one year after start
Surface groundwater P:	n/a
details:	from some months to several years (according to the depth of the groundwater table)

Effect crop yield or quality

Effect:	increase
Details and timing:	Increase in yield (by 5-10%) and decrease in plant nitrate concentration (for Welsh onion and curled-leaved endive)
Costs for investment, production and labour	Requests investments for tools to assess crop nitrogen status, but quick economical return according to high value crops considered
Global score economic feasibility	1
Details about the economic feasability	
Knowledge gaps	validation trials still required
References	M. Abras, S. Renard, J.P. Goffart, 2011. Gestion de la fertilisation azotée des légumes destinés au marché du frais en Wallonie (Belgique) - Evolution du statut azoté des cultures et fractionnement des apports. Rapport de projet de recherche CRA-W. ; Abras M , Baeten V and Goffart JP (2013). Management of nitrogen fertilization of fresh vegetable crops at field scale in Wallonia (Belgium); Splitting of nitrogen fertilizer applications and monitoring of crop nitrogen status (this Symposium). ; Goffart JP, Renard S., Frankinet M., Sinnaeve G., Delvigne A and Maréchal J. (2006). Leaf chlorophyll content measurements for nitrogen fertilization management of curled-leaved endives in open-field. Proceedings IS Towards Ecologically Sound Fertilisation. Strategies for field vegetable production (e ds F tei Benincasa and M Guiducci). Acta Horticulturae, 700: 207-211.
National or regional studies	

Code	WA05	Proposing country	**Belgium (Walloon region)**	Proposing institution	**CEHW**
Name	Composting rejected trees for soil amelioration				
Proposing person	Francoise Faux, francoisefaux@cehw.be				
Description	Composting rejected trees to make a microbiologically controlled compost. By adding farmyard manure, straw, green material and soil a C/N ratio of 30 is aimed.				
Rationale	Nutrient reduction is not the first aim of the composting technique. However, compost can store nutrients and therefore reduce nutrient losses. The resulting better soil structure can also reduce nutrient losses.				

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower	x	ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	x
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	x
Knowledge intensive for farmer	
Knowlegde gaps in research	x
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: Composting rejected trees to make a microbiological controlled compost. By adding farmyard manure, straw, green material and soil a C/N ratio of 30 is aimed.

score technical feasibility: -1

Details technical feasibility: Farmers believe in compost but it is difficult to urge them to produce the compost. Once the problem of cutting of trees is solved, it may be feasable.

Side effects for

organic carbon	+
weed and/or diseases	+
water use	0
other	+

details side effects:

At b: Positive effects if the compost is well made. Problems with Verticillium may be reduced. At d: Increased soil pH is possible.

Implementation

Phase: Preliminary field tests

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction: n/a

P use reduction: n/a

details nutrient use reduction: No tests were done.

Effect timing on

Soil N: n/a

Soil P: n/a

N loss reduction:	n/a	Surface groundwater N:	n/a
P loss reduction:	n/a	Surface groundwater P:	n/a
details nutrient loss reduction:	No tests were done.	details:	No tests were done.

Effect crop yield or quality

Effect:	increase
Details and timing:	By a better soil quality, better and more resistant (to plagues) plants can be achieved. More micro organisms in the soil ensure a better mineralization of organic matter and therefore less use of fertilisers.
Costs for investment, production and labour	First phase: costly. If some bottlenecks are resolved: less costly.
Global score economic feasibility	0
Details about the economic feasability	If the price of compost can decrease to the price of farmyard manure, the economic feasability is large (because you can reduce in manure use and fyto products)
Knowledge gaps	Composition, fabrication, price reductie for wood cutting
References	Teaming with microbes - Expériences de différents fabricants privés (C. Verhelst, Humus bvba, van Iersel)
National or regional studies	

Code	WA06	Proposing country	**Belgium (Walloon region)**	Proposing institution	**CEHW**
Name	Ploughless tillage				
Proposing person	Francoise Faux, francoisefaux@cehw.be				
Description	Ploughless tillage to reduce compaction. Tests were done to compare ploughing - spading machine - decompactor				
Rationale	Nutrient loss reduction is not the aim of the ploughless tillage adoption for ornamental trees. However, by reduction of compaction, a better soil structure is achieved, possibly resulting in less nutrient reduction.				

Subsector

horticulture open air	
greenhouse horticulture soil	
greenhouse horticulture soilless	
ornamentals soil	x
ornamentals soilless	

Farming system

conventional	x
organic	x

Involved nutrients

N	x
P	x

Crops

	early potatoes*		begonia
	peas		chrysanthemum
	beans		rose tree
	cauliflower	x	ornamental tree
	leek		tomatoes
	Brussels sprouts		pepper
	spinach		lettuce
	carrots		strawberries
	onions		flower bed/ balcony
	azalea		indoor plant

other crops:

crop yield:

Action domain

cropping technique	
crop choice/rotation plan	
fertilisation planning	
fertiliser type	
fertilisation technique	
crop residues	
water supply	
drain water	
catch crops	

Bottlenecks

Costs	x
Labour intensive	
Knowledge intensive for farmer	
Knowlegde gaps in research	
Increased risk of crop yield reduction	
Increased risk of crop quality reduction	
Legislation	
Other	

Details: The dimensions of the machine (decompactor) are too large for the generally small and dispersed fields of ornamental trees. Ploughs are smaller.

score technical feasibility: 0

Details technical feasibility: Farmers are not convinced yet.

Side effects for

organic carbon	+
weed and/or diseases	+
water use	+
other	+

details side effects:

Less plagues (eg Verticillium) are possible

Implementation

Phase: Research phase

Degree:

Details:

Expected effects on nutrient use and nutrient losses

N use reduction:	n/a
P use reduction:	n/a
details nutrient use reduction:	No tests were done
N loss reduction:	n/a
P loss reduction:	n/a
details nutrient loss reduction:	No tests were done

Effect timing on

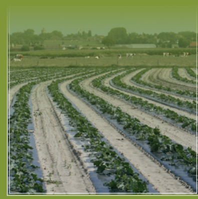
Soil N:	n/a
Soil P:	n/a
Surface groundwater N:	n/a
Surface groundwater P:	n/a
details:	No tests were done

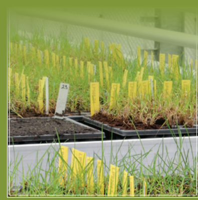
Effect crop yield or quality	
Effect:	increase
Details and timing:	Increase because of less plagues
Costs for investment, production and labour	The farmers do not plough or till their fields themselves, so they have to pay for the ploughing or ploughless tillage anyway.
Global score economic feasibility	2
Details about the economic feasability	Same costs as for ploughing
Knowledge gaps	Need for a machine adapted to the dimensions of the parcels. The effects of ploughless tillage on plagues as Verticillium needs to be researched in depth.
References	
National or regional studies	

NUTRIHORT

Nutrient management,
innovative techniques
and nutrient legislation
in intensive horticulture
for an improved water quality

September 16-18, 2013, Ghent





Fact sheets from the benchmark study on innovative techniques and strategies for reduction of nutrient losses in horticulture

Institute for Agricultural and Fisheries Research
Burg. Van Gansberghelaan 96
9820 Merelbeke - Belgium
T +32 (0)9 272 25 00
F +32 (0)9 272 25 01
ilvo@ilvo.vlaanderen.be
www.ilvo.vlaanderen.be

organised by

sponsored by