3 A practical case of nutrient management in the Southwest of the Netherlands

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3.1 Design of the nutrient management strategies

In this chapter, the general VEGINECO strategies for I/ENM (chapter 2.3) are applied to the situation in the Netherlands. In the following section, the same procedure is followed as in Chapter 2.3 (Figure 2.2). Part of the NL INT1 system (Brussels sprouts system with barley, fennel and potato) and the organic system (NL ORG) were chosen as examples of the nutrient management strategies tested.

3.1.1 Integrated system

Nutrient demand
Fertilisation advice levels are well established for most vegetable crops (based on experimental research). Nutrient demanddemand isis based on these advice levels. Soil organic mineralisation and deposition are taken up in the nutrient demand. The amount of nutrients in irrigation water was ignored.
The nitrogen demand is summarised in (Table 3.1, column 1). Potatoes and Brussels sprouts are crops with high demands. The phosphate and potash demands are equal to the off-take as is presented in Table 3.3 column 5 and 6).

Nutrients from non-fertilisation sources
In the Dutch integrated system, non-fertilisation sources that contributed to nutrient availability came from crop residues only. No green manures could be used because of the late harvest of the crops. Relatively little is known about the nitrogen content and amount of crop residues. There are no standard guidelines for the working coefficient of crop residues or soil organic matter mineralisation. However, this is not a problem in fertilisation practices in integrated systems because the fertilisation is based on repeated measurements of N-min in the soil. In this way, mineralisation from crop residues is measured directly. The contribution of crop residues is presented in Table 3.1 column 5.

Fertilisation
The nutrient demand had to be supplied by fertilisation except for a small amount of nitrogen in crop residues. Most nutrients were supplied through mineral fertilisers. Manure is not necessary for the organic matter balance. Champost was used to help to close nutrient cycles at higher levels. Champost was applied in autumn. It is mainly used to stabilise the organic matter content of the soil. Because of the relative low working coefficient (35%) (See Annex 5 for working coefficients of different organic fertilisers), it only adds 20 kg ha^{-1} to the nitrogen availability (Table 3.1, column 7). 20 ton of Champost ha^{-1} was applied before fennel and potato. These crops required the most potash and Champost is rich in potash. Nitrogen fertilisation is crop-specific. The recommended levels are based on mineral nitrogen in the soil measured before sowing. For most crops, split dosage systems for nitrogen are available (guided fertilisation). For fennel, these are based on repeated N-min assessments. For potato and experimentally for Brussels sprouts, these are based on repeated measurements of nitrogen in leaf stalks.

As the soil fertility is, on average, within the desired range, phosphate and potash fertilisation is balanced with off-take. Exceptions are:

- 20 kg ha^{-1} was added as compensation for unavoidable losses for phosphate.
- If soil fertility of phosphate is within or lower than the desired range, all crops planted or sown before May 15th receive a phosphate fertiliser. This fertilisation of early crops was reduced from the standard of 50 kg ha^{-1} to 20 kg ha^{-1} by using a row application of polyphosphates.

Table 3.1 Nitrogen demand and planned nitrogen availability (kg ha^{-1}), split in different sources for NL INT1. Ideally, nitrogen demand should be equal to total nitrogen availability for each crop.

Year	Crop/green manure	N-required	Total N-availability	N-availability from internal sources			N-fixation	N-availability from fertilisers	
				Total	Green manure	Crop residues		Organic	Mineral
		1	2=3+7+8	3=4+5	4	5	6	7	8
1	Fennel early	120	121	0	0	0	0	41	80
	Fennel autumn	100	118	58	0	58	0	0	60
2	Potatoes	190	191	0	0	0	0	41	150
3	Brussels sprouts	220	220	0	0	0	0	0	220
4	Spring barley	70	67	17	0	17	0	0	50
Average		**175**	**179**	**19**	**0**	**19**	**0**	**20**	**140**

Table 3.2 Planned organic and mineral fertilisation (kg ha-1), NL INT1, organic manure was applied before fennel and potato (20 ton ha-1 champost)

Year	Crop / green manure	N		P_2O_5		K_2O	
		Org	Min	Org	Min	Org	Min
1	Fennel early	116	80	72	50	174	54
	Fennel autumn	0	60	0	0	0	0
2	Potatoes	116	150	72	0	174	226
3	Brussels sprouts	0	220	0	50	0	0
4	Spring barley	0	50	0	0	0	0
Average		**58**	**140**	**36**	**25**	**87**	**70**

- If the soil fertility levels of phosphate or potash are lower than the desired range, repair doses are applied. For phosphate, 50 kg ha-1 per Pw-point and for potash 100 kg ha-1 per K-count point was applied for every point lower than the desired level.

Most of the phosphate and potash for the entire cropping plan was applied before the crops that need these minerals were planted such as phosphate before early (leaf) crops and potash before potatoes. Mineral phosphate fertiliser was applied before fennel and Brussels sprouts. Mineral potash was applied before fennel and potato. Phosphate and potash were applied to balance the fertilisation over the entire cropping plan.

An overview of the nutrients applied with fertilisation is presented in Table 3.2.

Evaluation and optimisation

In the average rotation, nutrients are sufficiently available (Table 3.3 for phosphate and potash and Table 3.1 for nitrogen). Normally nitrogen availability is almost equivalent to the nitrogen demand. In practice, testing should indicate if the planned fertilisation is sufficient enough for the optimal quality and quantity of the produce.
It is expected that emissions of phosphate and potash would be limited because surpluses were limited. The nitrogen surplus was rather high with on average 90 kg ha-1. Large differences existed at a crop level (Table 3.3, column 7). The surplus was high for early fennel, Brussels sprouts and potatoes, and very low for spring barley. The N-min after harvest (based on expert evaluation) was expected not to exceed the maximum limit of 70 kg ha-1. However, the N-min at start of the leaching season was expected to be too high for potatoes. On average, the expected N-min after harvest and at the start of the leaching season was expected to be well below the desired level of 70 kg ha-1.

3.1.2 Organic system

There are not recommended standards for fertilisation currently available for organic systems. This was reflected in the large variation in fertilisation strategies between organic farms, which was observed in the BIOM project (Wijnands, 2000).

Nutrient demand

Nutrient demand was derived from conventional experiments and adjusted for the organic system. Organic mineralisation and deposits in soil were included in the nutrient demand. The amount of nutrients in irrigation is negligible. Nitrogen demand is summarised in Table 3.4 (column 1). Phosphate and potash demand is equal to the average off-take. Average off-take is summarised in Table 3.5 (column 6, 7 and 8).

Nutrient availability non-fertilisation sources

In NL ORG, non-fertilisation sources that contribute to nutrient availability are from green manures and crop residues. In the rotation, optimal use is made of the

Table 3.3 Nutrient balance (kg ha-1) NL INT1

Year	Crop / green manure	Input			Off-take			Surplus		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
		1	2	3	4	5	6	7=1-4	8=2-5	9=3-6
1	Fennel early	196	122	228	40	10	120	156	112	108
	Fennel autumn	60	0	0	40	10	120	20	-10	-120
2	Potatoes	266	72	400	149	50	230	117	22	170
3	Brussels sprouts	220	50	0	99	38	108	121	12	-108
4	Spring barley	50	0	0	105	56	42	-55	-56	-42
Average		**198**	**61**	**157**	**108**	**41**	**155**	**90**	**20**	**2**

Table 3.4 Nitrogen demand and nitrogen availability (kg ha^{-1}) are split into different sources for NL ORG. Ideally, nitrogen demand should be equal to total nitrogen availability for each crop.

Year	Crop/green manure	N-demand	Total N-availability	N-availability from internal sources			N-fixation	N-availability from fertilisers	
				Total	Green manure	Crop residues		Organic	Dried blood
		1	2=3+7+8	3=4+5	4	5	6	7	8
1	Iceberg lettuce summer	105	103	10	10	0	0	58	35
	Iceberg lettuce autumn	60	104	60	10	50	0	29	15
2	Spring barley	50	0	0	0	0	0	0	0
	White clover	0	0	0	0	0	100	0	0
3	Brussels sprouts	170	175	50	50	0	0	125	0
4	Fennel early	105	112	17	0	17	0	0	95
	Fennel autumn	60	93	58	0	58	0	0	35
5	Spring barley	50	0	0	0	0	0	0	0
	White clover	0	0	0	0	0	100	0	0
6	Potatoes	130	135	50	50	0	0	25	60
	Vetch/grass	0	56	48	0	48	80	8	0
Average		**122**	**130**	**49**	**20**	**29**	**47**	**41**	**40**

green manures white clover and vetch/grass. White clover was utilised as under sowing with summer barley. White clover fixates 100 kg nitrogen ha^{-1} of which 50% is available for uptake by the crop in the next growing season. Vetch/grass fixates 80 kg nitrogen ha^{-1} of which 25% is available for uptake by the crop in the next growing season. In Table 3.4 (column 3, 4 and 5), the availability from internal sources is presented. The nitrogen demand of 122 kg ha^{-1} so 73 kg ha^{-1} had to be supplied with fertilisers.

Fertilisation

All of the phosphate and potash required and 60% of the nitrogen required had to be supplied with fertilisation. Organic manure was given to the crops with the highest demands and with the highest financial return. Experience has shown that it is most difficult to supply sufficient amounts of phosphorus. Therefore, the first step is to fulfil phosphorus demand and adjust for the expected unavoidable losses of 20 kg ha^{-1}. At least two thirds of the phosphate supplied with manure needs to be from solid manures. This rule is set to supply a sufficient amount of fresh organic matter to the soil in addition to nutrients, and to create a soil with a higher mineralisation potential, which can lower nutrient required from fertilisers in the long term.

Solid and liquid cow manure were chosen as fertilisers because the nitrogen and phosphate availability corresponds the best to the fertilisation demand for the crop compared to other animal manures. In addition, these manures were readily available.

Manure was applied before the crops with high nutrient demands. Solid cow manure was applied in the autumn after clover but before ploughing. Solid cow manure can not be applied in spring because of the difficulty of use.

Liquid cow manure is applied in spring shortly before crop growth. 30 ton ha^{-1} liquid cow manure was used before iceberg lettuce because nitrogen is directly available. Brussels sprouts require a lot of nitrogen so before it is planted, 30 ton ha^{-1} liquid manure is applied. If an insufficient amount of nitrogen is available for crops that have high yields from internal sources and manure, then dried blood is applied. The input of the dried blood can possibly in future be replaced by the organic matter mineralisation. In Table 3.4 (column 8) indicates for which crops dried blood is applied and which amounts are used.

Evaluation and optimisation

In the average rotation, nutrients are sufficiently available. The results show in Table 3.5 (column 8 and 9) that the average phosphate and potash surpluses were close to or larger than zero (phosphate included the unavoidable loss of 20 kg ha^{-1}). Table 3.4 (column 1 and 2) shows that the average nitrogen availability was larger than the average amount of nitrogen required. At a crop level, however, the nitrogen availability for barley was 50 kg ha^{-1} too low. Barley is a crop with low financial return, so the low nitrogen availability was acceptable. Iceberg lettuce and fennel in the autumn have too much nitrogen available because nitrogen is mineralised from the fertilisers during early growth. In practice, testing should indicate if the planned fertilisation is sufficient enough for the optimal quality and quantity of the produce, and if the remaining nitrogen in the soil is within acceptable levels.

Surpluses are presented in the last part of Table 3.5 (column 7 to 9). It was expected that emissions of phosphate and potash would be limited because surpluses were limited. Large differences existed in nitrogen surplus

Table 3.5 Nutrient balance (kg ha[-1]), NL ORG. Nutrient off-take of phosphate and potash is equal to nutrient demand. Input consists of animal manure and dried blood. The amount of nitrogen applied with animal manure only can be calculated by subtracting the amount of dried blood applied (Table 3.4 column 8) from the total input of nitrogen (this Table, column 1).

Year	Crop / green manure	Input			Off-take			Surplus		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
		1	2	3	4	5	6	7=1-4	8=2-5	9=3-6
1	Iceberg lettuce summer	179	51	195	38	13	63	141	38	132
	Iceberg lettuce autumn	15	0	0	38	13	63	-23	-13	-63
2	Spring barley	0	0	0	90	48	36	-90	-48	-36
	White clover	100	0	0	0	0	0	100	0	0
3	Brussels sprouts	337	184	318	77	29	84	260	155	234
4	Fennel early	95	0	0	36	9	108	59	-9	-108
	Fennel autumn	35	0	0	36	9	108	-1	-9	-108
5	Spring barley	0	0	0	90	48	36	-90	-48	-36
	White clover	100	0	0	0	0	0	100	0	0
6	Potatoes	225	114	105	114	39	179	109	75	-74
	Vetch/grass	80	0	0	0	0	0	80	0	0
Average		**195**	**58**	**103**	**87**	**35**	**113**	**108**	**24**	**-10**

at a crop level (Table 3.5). It was expected that N-min after harvest (based on expert evaluation) did not exceed the maximum limit of 70 kg ha[-1]. However, the expected N-min at start of the leaching season was expected to be too high for iceberg lettuce in the autumn. On average, the N-min after harvest and at the start of the leaching season was expected to be well below the desired level of 70 kg ha[-1].
The mineralisation of soil organic matter was still not accounted for in the nitrogen availability. If organic manure is continuously applied, then the extra mineral nitrogen from soil organic matter needs to be taken into account.

3.2 Testing and improving

3.2.1 Results for each parameter

Overview of desired and achieved levels of parameters related to IENM
In Tables 3.6 and 3.7, an overview is presented of the desired and achieved levels of the parameters related to IENM.

Annual balance of phosphate and potash (PAB, KAB)
The desired levels for phosphate and potassium Annual Reserves were within the desired range (Table 3.6). According to the fertilisation strategy, phosphate and

Table 3.6 Desired level and achieved level of parameters related to IENM of NL INT1 (see Annex 2 for explanation of parameter acronyms)

Theme	Parameter	Desired level	Realisation 1997	1998	1999	2000
Environment						
Nutrients	PAB	1.0	1.15	0.91	0.81	1.06
	KAB	1.0	0.84	1.25	1.04	1.03
	NAR	<70 kg ha[-1] (0-100 cm)	58	25	33	32
Sustainable use of resources	PAR	20 < Pw < 30	30	28	29	24
	KAR	20 < K-count < 29	26	24	23	23
	OMAB	>1	1.5	1.7	1.5	1.4
Quality Production	QNP	1.0 (GAP)	0.95	0.71	0.90	0.96
	QLP	1.0 (GAP)	0.99	0.92	0.80	0.88
	NCONT	1 (<2 500 ppm)	1	1	1	1

Table 3.7 Desired level and achieved level of parameters related to IENM of NL ORG (see Annex 2 for explanation of parameter acronyms)

Theme	Parameter	Desired results	Realisation 1997	1998	1999	2000
Environment	PAB	1.0	0.70	0.93	1.19	1.42
Nutrients	KAB	1.0	2.62	0.93	1.77	1.85
	NAR	<70 kg ha^{-1} (0-100 cm)	80	14	52	41
Sustainable use of resources	PAR	20 < Pw < 30	29	29	29	23
	KAR	20 < K-count < 29	25	24	25	25
	OMAB	>1	1.4	1.3	1.4	1.4
Quality Production	QNP	1.0 (GAP)	0.72	0.73	0.85	0.61
	QLP	1.0 (GAP)	0.49	0.64	0.65	0.71
	NCONT	1.0 (<2 500 ppm)	1	1	1	1

potash input in fertilisers should then be equal to the phosphate and potash off-take in the produce (averaged over the experimental years). For phosphate, the off-take is raised with 20 kg ha^{-1} of unavoidable losses (input = off-take + 20 kg ha^{-1}). A circumstantial surplus or shortage in previous years was compensated in the following years.

In NL INT1, the average PAB and KAB for the period 1997-2000 was 1.0, which is equal to balanced fertilisation. In NL ORG, the average PAB was close to 1.0 as well. However, the KAB was on average 1.8, which was too high. The high KAB was caused by the variation in the nutrient content of the organic manure and the ratio between phosphate and potash in the manure. It was not possible to lower KAB without adding sufficient phosphate and nitrogen to the rotation. Phosphate-potash ratios of manure normally do not correspond with the desired phosphate/potash ratio of the rotation.

Nitrogen available reserves at the start of leaching season (NAR)

In most years, the NAR was lower than the target level of 70 kg ha^{-1} in NL ORG as well as in NL INT1 (Figure 3.1). Only in NL ORG in 1997, the NAR at a system level was higher than the target. The data for NAR of 1998 was taken too late because of the wet weather conditions. At this date, a lot of the mineral nitrogen had probably already leached out of the soil. Therefore, they were not comparable with the data from the other years and the target levels. In addition, nutrient off-take was low and surplus was high because the potatoes were not harvested.

The NAR at a farm level is very dependent of the type of crops in the rotation. In the integrated system, (NL INT1) none of the crops had a high NAR, thus the farm level was relatively low. In the other integrated system (NL INT2) with iceberg lettuce, the actual level was close to the desired level (69 kg ha^{-1}) because of the high NAR

Table 3.8 Average Nitrogen Available Reserves per crop and per system for NL INT1 and NL ORG) (layer 0-100; kg ha^{-1}) in November 1997, December 1998, November 1999 and November 2000

Crop	Integrated 1997	1998	1999	2000	Organic 1997	1998	1999	2000
Brussels sprouts	34	20	20	36	15	11	22	14
Cauliflower	65[1]	50[1]	20[1]	12	-	-	-	-
Celeriac	34	20	41	55	-	-	-	-
Cereals	47	25	36	46	38	16	19	44
Fennel	124	32	70	66	124	15	56	12
Grass/clover	-	-	-	-	-	16	22	18
Iceberg lettuce	111	44	123	134	140	17	81	42
Potato	48	29	30	28	124	10	110	104
System	**58**	**35**	**33**	**32**	**80**	**14**	**52**	**41**

[1] Except Winter Cauliflower

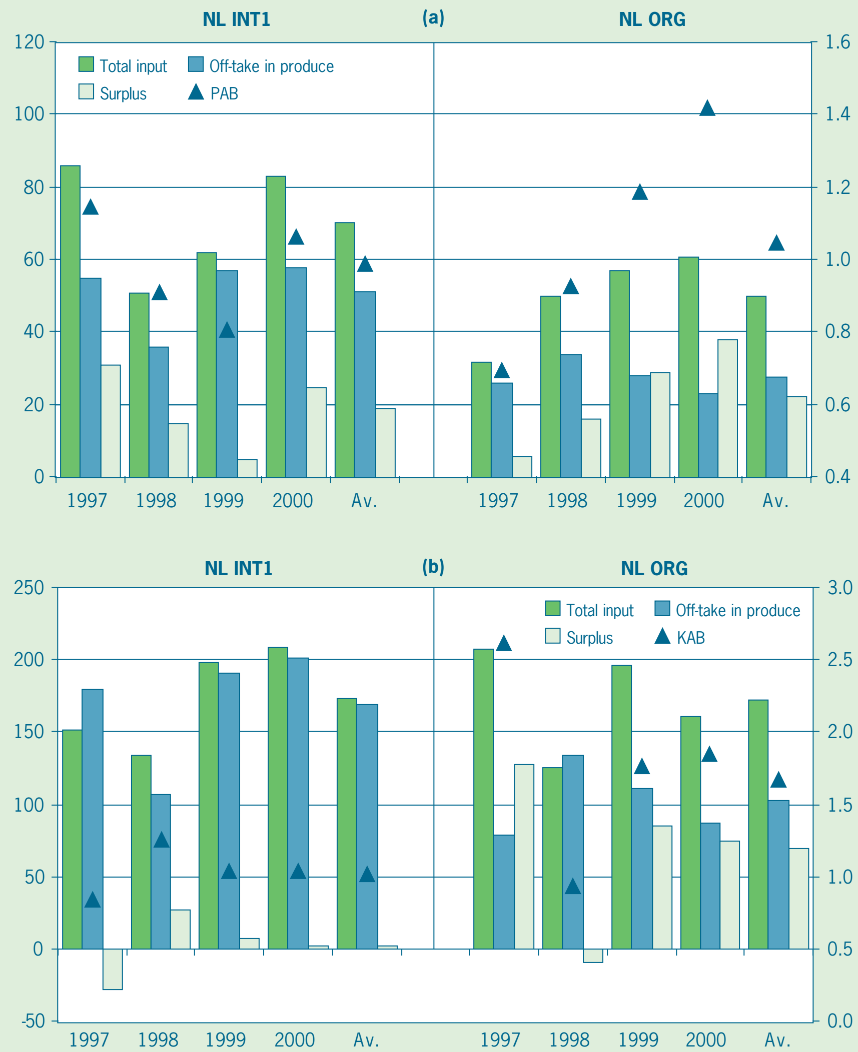

Figure 3.1 Phosphate (a) and potassium (b) input, off-take and surplus (left y-axis, (kg ha^{-1})) and phosphate and potassium Annual Balances (PAB and KAB, right y-axis (-)) for NL INT1 and NL ORG

after the cultivation of iceberg lettuce. In NL ORG, iceberg lettuce and potato caused a high NAR. Iceberg lettuce had a high NAR because of the low efficiency and large amounts of crop residues. Potato had a high NAR caused by an early harvest because of late blight.

Available reserves of phosphate and potash (PAR, KAR)

Available reserves of phosphate and potash were on average throughout the fields within the desired range for both systems (Pw between 20 and 30, K-count between 20 and 29). Variations between years and between systems were small. In order to maintain these levels for the long term, balanced fertilisation for potash and a surplus of 20 kg ha^{-1} for compensation of unavoidable losses for phosphate were used.

Organic matter annual balance (OMAB)

In sustainable farming, effective organic matter input should be higher than decomposition. For this reason, it was necessary in integrated as well as in organic systems to apply organic manure and input crop residues.
Input sources of effective organic matter are:

- Organic manure: Champost in the integrated systems, and solid and liquid cow manure in the organic system.
- Green manures: clover, yellow mustard, phacelia and grass clover in the organic system, no green manures were used in NL INT1.
- Crop residues: especially Brussels sprouts and spring wheat/barley add a large amount.
- Peat pots.

Decomposition is calculated by multiplying the amount of organic matter in the tillage zone by the decomposition coefficient. The decomposition coefficient was estimated at 2.5% per year. The amount of organic matter in the tillage zone (0 – 30 cm) was higher in NL ORG (3.1%) than in NL INT1 because of a higher organic matter content (2.3%).
Subsequently, total decomposition in the organic system was estimated higher than in NL INT1.
Table 3.9 gives an estimation of the OMAB. It appears that for both systems, OMAB was well above one. For OMAB in both systems, organic manure was not necessary. However, organic manure was necessary for nutrient supply in the organic system. In the integrated system, organic manure was used to close nutrient cycles.

Quality and quantity of produce parameters (QLP, QNP)

In order to calculate QLP and QNP at a system level for every crop, a target for yield and quality was set. The level at which the targets were set should reflect the Good Agricultural Practice (GAP). The targets were equal to average practice.
In NL INT1, the realised levels for quantity and quality almost reached the desired levels. It is assumed that nutrient availability was sufficient to reach yield quantity

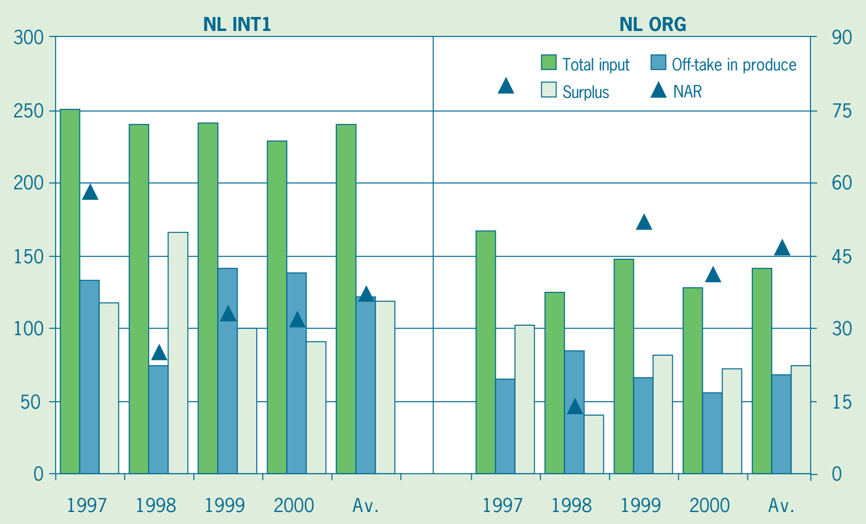

Figure 3.2 Simplified Nitrogen balance (left y-axis, (kg ha-1)) and Nitrogen Available Reserves at the start of the leaching season (NAR, right y-axis (kg ha-1, 0-100 cm)) for NL INT1 and NL ORG

and quality targets. Yield quantity and quality was most influenced by external factors (weather), diseases, and plagues, which were not treated sufficiently.

For organic farming, there was hardly any data available to support the quantification of the Good Agricultural Practice (GAP) in terms of yield and quality. The calculated QNP and QLP was an average for all the crops in one system. Comparing the results (Table 3.7), QNP varied from 61 to 85% of the target values and QLP improved over the years with 20%. In addition to problems in crop protection, nitrogen supply needs to be improved for all crops to reach target values.

Nitrate content in crop produce (NCONT)

Nitrate content in crop produce was only measured for iceberg lettuce and fennel. No crop or cultivation exceeded the target level of 2 500 ppm. Values for iceberg lettuce were always below 750 ppm; values for fennel varied between 500 and 2 000 ppm. Nitrate levels in the integrated systems were always higher than in the organic system, probably because of higher nitrogen availability in the integrated systems.

Table 3.9 Example of the organic matter annual balance (OMAB) for NL INT1 and NL ORG in 1997, inputs and decomposition in kg effective organic matter ha-1

	NL INT1	NL ORG
Total Input	*3 416*	*3 533*
Crop residues	1 579	1 156
Green manure	0	519
Peat pots	838	825
Organic manure	1 000	1 033
Decomposition	*1 898*	*2 558*
OMAB	1.8	1.4

Energy input (ENIN)

Nutrient management influences energy efficiency by fertiliser choice. To produce mineral fertilisers (especially nitrogen), a lot of energy is required, while production of organic manure cost no energy. This is reflected in the energy use between the organic and integrated system. To produce iceberg lettuce organically, 1 340 MJ ha-1 is required for fertilisation, while for integrated production 9 040 MJ ha-1 is needed. Of the total energy needed to produce one hectare of iceberg lettuce, in the integrated system, 22% of the energy is needed for fertilisation while in the organic system, only 4% is needed. No target value was set because ENIN is a new parameter.

3.2.2 Optimisation of nutrient management

Changes have been made over the four years of testing and improving to optimise the integrated and organic systems.

Integrated systems

In the rotation, the period between two iceberg lettuce crops had been increased. In this way, the succeeding crop could make better use of the nitrogen released in the crop residues of the previous crops. It is expected that NAR of iceberg lettuce, which is very high, will be lowered with this measure.

In fertilisation, different changes had taken place:

- Early crops received a row application of polyphosphates of 20 kg ha-1. Before, a gift of 50 kg ha-1 was given. If every early crop received a gift of 50 kg ha-1, the phosphate Annual Balance (PAB) would be larger than 1. In the row application, PAB can be lower than one when necessary.
- Leaf stem method to determine the nitrogen required by Brussels sprouts was developed and tested. The leaf stem method allows the input to be adjusted better to the crops' nitrogen requirements. This could enhance quality and quantity production.
- Adjustments of fertilisation levels for different crops improved quality and quantity of production:
  - Brussels sprouts: nitrogen fertilisation of Brussels sprouts was raised to obtain sufficient plant height.

- The initial nitrogen gift for cauliflower had been increased from 200 – N-min to 225 – N-min.
  - The initial gift of nitrogen for iceberg lettuce had been changed from 80 – N-min to 100 – N-min.
  - The nitrogen gift for potatoes had been based on the cultivated variety.
- Sulphur shortage was found in Brussels sprouts, which influenced quality and quantity of production. Sulphur reserves in the soil have been assessed and shortages have been solved with top dressings. In addition, sulphur fertilisation was carried out for Brussels sprouts before cultivation based on assessment of sulphur reserves.

Organic system

Rotation:

- Grass-clover was introduced to replace one of the barley crops. The clover under sown in the barley appeared to be variably successful. The replacement was done to ensure that sufficient nitrogen was brought in to the system by fixation.
- The green manure type after the potato was changed to a non-leguminous crop. Originally vetch was included in the plans, but because of the high amount of mineral nitrogen in the soil after potatoes, it was decided to choose for yellow mustard, phacelia or fodder radish. The use of a non-leguminous green manure should lower NAR-values.
- The period between two iceberg lettuce crops has been lengthened. In this way, the succeeding crop can make better use of the nitrogen released from the crop residues of the previous crops. It is expected that NAR of iceberg lettuce, which is very high, will be lowered with this measure.

Fertilisation:

- Animal manure application:
  - Use of more composted and less straw-rich, solid cow manure allowed better application in the field.
  - Use of a ‘sleepslangen’ machine for liquid cow manure could be spread better.
  - Other amounts of manure, liquid manure was used more to better meet the nitrogen demand.
- Hydrolysed blood:
  - Earlier application of hydrolysed blood shortly before planting so that nitrogen would be available in time. This means that hydrolysed blood cannot be used when crops have shortages because it is slow mineralisation. By applying hydrolysed blood before planting, efficiency of application was improved and quality and quantity of production was possibly higher.
  - More hydrolysed blood was applied before iceberg lettuce because of nitrogen shortages and subsequently low quality and quantity of production.
- Straw from barley was applied to the iceberg lettuce field after harvest to lower NAR. Storage of straw and application of straw appeared to be difficult. The effect of application is (still) unknown.
- The nitrogen gift for potatoes had been based on the cultivated variety.

In addition, the ecoplough was used in combination with a device for breaking the old plough-layer instead of the normal ploughing method. This improved nitrogen availability by enhancing mineralisation in the upper layers. The ecoplough ploughs only 10-15 cm. The problem in using it was the creation of a plough layer and the soil structure declined. If use of the ecoplough has stimulated nitrogen mineralisation and has improved yield quality and quantity is questioned.