

**Project ‘Annual Nutrient Cycling Assessment (ANCA)’**

Additional information, movies included: www.mijnkringloopwijzer.nl

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**Background and objective**

In dairy farming, cropping and animal husbandry are connected, what is different from arable or intensive livestock farming. In the Netherlands, on average 70% of the consumed feed is grown on the farm land. Of the nutrients used to fertilise the grassland and fodder crops 65% (nitrogen) to 100% (phosphorus) consists of excretion products from the herd: liquid manure and solid manure produced indoors and droppings during grazing. Consequently, dairy farming is characterised by strong cycles of nitrogen (N), phosphorus (P), and carbon (C): feed turns into manure and manure turns into feed. Losses of nutrient from those cycles, by selling milk and cattle and through emissions are compensated by purchasing feeds and fertilisers.

More efficient use of feeds and fertilisers results in a better cycling of nutrients and therefore in lower losses to the environment and less costs for purchases. Efficiency is partly governed by conditions that cannot be affected by the dairy farmer, such as soil type or weather conditions. However, management generally is the most dominant factor.

Objective of the project is the development of the instrument ANCA (in Dutch: kringloopWijzer), with which the N, P and C cycles of the individual dairy farm can be estimated scientifically correct. Input farm data have to be easily collectable and should be checkable, because ANCA has to be exploitable by farmers and should be fraud resistant. With the values of a set of indicators, derived from these cycles, the dairy farmer can justify his farm performances towards governments and milk processing industry. Besides, it provides him information to optimise his management. The potential benefits of the instrument ANCA is discussed in detail further on in this document. The introduction of the instrument on commercial farms is part of the project. The project is running during the period 2012 - 2014.

Execution of the project involves almost all organisations, involved in Dutch dairy farming: farmers’ unions, supplying and processing industries, knowledge institutes and governments. These stakeholders agreed that, onwards from the beginning of 2015, the use of ANCA should be mandatory for all dairy farms that produce more excrememts than they are permitted to apply on their own fields (about 250 kg N/ha and 90 kg P2O5/ha). For the less intensive farms the use of ANCA will strongly be encouraged.

**Indicators of the quality of cycling, generated by ANCA**

Estimating the cycles on the dairy farm follows a step-by step procedure and ultimately leads to the following indicators, quantified on an annual basis. They are presented for several years, thus also showing the development over time.

Their positions in the cycle are presented in Figure 1.

1. Manure production: nitrogen (N) and phosphate (P2O5) excretion of cattle (kg/ha);
2. Efficiency of feeding: conversion of N and P2O5 from feed into milk and meat (%);
3. Ammonia (NH3) emission, divided over housing, manure storage, grazing, manure spreading and mineral fertiliser application (kg/ha);
4. Yield grassland and maize land: dry matter, N, and P2O5 (kg/ha) and energy (kVEM/ha),
5. Efficiency of fertilisation: conversion of N and P2O5 from chemical fertilisers and organic manures into crop yield (%);
6. Soil surplus N, P2O5 and C (including the longer term development of soil stores; kg/ha);
7. Nitrate (NO3) in groundwater (mg/l);
8. Emission of the greenhouse gases methane (CH4), nitrous oxide (N2O) and carbon dioxide (CO2) (kg/ha);
9. Farm surplus N, P2O5 and C (kg/ha);
10. Efficiency of farming: conversion N and P2O5 from bought product (mainly feeds and fertilisers) into sold milk and animals (%).

Reference and normative values are added to the farm performances. Reference values may be the average values achieved by farms under similar conditions or, e.g., the values of the 25% best performing farms. Normative values can be values for ‘good agricultural practice’ or values on which legislation is based. An example: the European Nitrate Directive stipulates that the nitrate concentration of groundwater should not exceed 50 mg/l. This is the normative value. Reference and normative values allow the farmer to compare the performances of his farm with those of his colleagues as well as with the target values laid down by the government.

Figure 1. Position of the ANCA indicators in the cycle(see numbers above).

**8**

Milk/animals

**3 8**

feed

**2**

manure

**5**

**1**

**9 10**

**4**

**3**

**6**

fertilisers

**3**

**7 8**

ANCA is only dealing with the emissions from the cycles on the farm itself, the so called ‘on farm’ emissions. However, the production and transport of feed and fertilisers purchased by the farm also caused emissions. These ‘off farm’ emissions can be expressed as a coefficient per unit purchased product. By multiplying each purchase of the farm with its coefficient, and summing up the results, the off farm emissions can be estimated. However, this calculation procedure is no part of the development of ANCA. Nevertheless, a farmer should be aware that off farm emissions can be reduced by buying products that are relatively low in off farm emissions.

Figure 2. ‘On farm’ and ‘off farm’ emissions. ANCA estimates only the on farm emissions.

**ANCA**

Off farm emissions

Off farm emissions

Feeds

Fertilisers

Fuels

On farm emissions

Dairy farms

Milk

Meat

Manure

Transport and processing milk, meat and manure

Production of milk and animals on the dairy farm

Production and transport to the dairy farm

Values for farm performances, estimated by ANCA, are only reliable for the about 80% rather conventional specialised Dutch dairy farms. The remaining 20% farms are mixt with other agricultural activities or managed too atypical.

**Project execution**

The cycles should be estimated in a scientifically correct and transparent way. The mathematical equations, to be developed, need approval by the leading (inter)national experts in the relevant domain. Investigated was that the equations can be fed for 95% with data that are digitally recorded and stored by suppliers, purchasers, governments and other relations of the dairy farm. For the remaining 5% research has to be done how to collect these data reliable and controllable. As a result, data can be connected with the mathematical rules without involvement of the farmer. This restricts administrative burdens and makes correct use verifiable. A common structure is being developed for data collection, data storage and data transport.

The combination of mathematical equations and reliable farm data yields in farm-specific values of the indicators. This is followed by establishment of the reference and normative values. The farm report presents the farm-specific values and clarifies deviations from reference and normative values, by proving more detailed background information.

Figure 2. Procedure ANCA

mathematical equations

specific farm data

farm specific values farm indicators

reference values

normative values

farm report

The instrument ANCA is a modular extension of BEX, a calculation tool, developed by the project Cows & Opportunities, that quantifies the herd part of the N and P farm cycles. It calculates the farm specific excretion of the herd as feed intake minus the production of milk, calves and additional bodyweight. Most Dutch dairy farmers are already using BEX. If N or P2O5 excretions are below the national standards, the authorities accept the farm-specific outcome, what leads to lower costs of export of manure. Besides, the farmer is informed with facts about the efficiency of feeding, which enables him to optimise his management.

Similar to the development of BEX, each new module is first technically tested with the farm data of the ‘De Marke’ experimental farm and subsequently with those of the 16 commercial pilot farms in the project Cows & Opportunities. Reliable data were collected on these farms throughout many years. After required adjustments, larger groups of farmers, often together with their advisors, are testing practicability, user-friendliness and enforceability (fraud-sensibility). This may again lead to further adjustments.

**Stakeholder’s benefits**

The project is a private-public collaboration in the context of the Top Sector Policy of the Dutch government. This means that the results of the project should be beneficial for the government (public interest) as well as for private businesses. The potential benefits for each of the stakeholders are briefly presented below.

Dairy farmers

1. The dairy farmer can show his milk processor and national and local governments that the milk has been produced without wasting scarce resources or causing unacceptable levels of emissions.
2. ANCA informs the dairy farmer about the strengths and weaknesses of his farming system, by presenting values for indicators, thus enabling appropriate measures to be taken, including the update of knowledge and skills.

Governments

*National*

1. The national government wants to meet the desired quality of the environment, to stimulate the efficiency of the use of scarce resources and to support an economically strong dairy sector. Incorporation of ANCA in such a policy can contribute to all this. Until now environmental legislation consists of obliged generic regulations with which the government in fact dictates how to manage the farm, assuming average conditions. ANCA offers possibilities to differentiate legislation to specific farm conditions. An example. The generic fertilisation standards for sandy soils are based on the average annual yields achieved by farms on those soils. ANCA calculates the achieved yield for the individual farm (indicator 4). Entering the farm-specific yield in the formula used to calculate the generic fertilisation standard results in a farm-specific fertilisation standard that may be higher or lower. Besides, governments can provide the farmer the ability to select those measures that fit best to realise the environmental targets in the specific situation. Providing farmers freedom in the choice of measures in case good indicator scores are obtained may stimulate economic sustainability of dairy farming.
2. Relatively low emissions (indicators 3, 6, 7 and 8) shown with ANCA may possibly be used in the context of the ‘greening’ paragraph of the new European agricultural policy, because restriction of the N and P losses may strengthen the biodiversity in the surroundings of the farm.
3. The extent of derogation (deviation from the 170 kg N criterion organic manure application, ordered by the Nitrate Directive) can be made dependent on the achieved efficiency of the utilisation of fertilisers (indicator 5) and/or realised soil surplus (indicator 6).
4. Knowledge and innovations as results of investments in research will be sooner implemented in practice when resulting improvement of the environmental quality is rewarded. ANCA can objectively visualise such improvements.

*Local*

1. Recently, provinces have been given more responsibilities for nature and environmental policies. This, for instance, involves them in Natura 2000 areas where (locally) additional measures are required to, e.g., sufficiently restrict the ammonia load. ANCA may help in a way the farmer considers meaningful and to which a reward system can be linked. A number of provinces are already experimenting with ANCA in this way.
2. Several local Water Board Authorities have to take measures, in addition to the national ones, to meet the water quality requirements laid down in the Water Framework Directive. ANCA can contribute to realise these region specific environmental targets.

Milk processors

1. Milk processors want to guarantee the buyers of their products that the processed milk has been produced in an environmentally acceptable way. This can be made controllable with ANCA.
2. Most milk processors have agreed a sustainability strategy and route with their milk delivering farmers. This includes a reduction of harmful emissions. ANCA is verifiably mapping these emissions and their development over time.
3. Most milk processors are cooperatives with dairy farmers as their members. This means that the arguments given under ‘Dairy farmers’ do also apply for these milk processors.

Farming industries

1. Representatives of the feeds and fertilizers suppliers, independent farm advisors and veterinarians wish to support their clients in the best possible way to properly manage the increasingly complex farm. They can work more efficiently (and thus gain appreciation) when in their conversations with the farmer they have access to reliable, uniformly calculated values of farm indicators.
2. The supplying industry is better able to match their feeds and fertilizers with the needs of the dairy farmer.
3. The supplying industry developed a sustainability strategy in which ANCA can play a useful role.
4. Many suppliers of feeds and fertilisers are cooperatives, with dairy farmers as members. This means that the arguments given under ‘Dairy farmers’ do also apply for these suppliers.