Enhancing biodiversity on arable farms in the context of environmental certification schemes

Manhoudt, A.G.E.

2

ENVIRONMENTAL LABELLING[1] IN THE NETHERLANDS: A FRAMEWORK FOR INTEGRATED FARMING

Astrid Manhoudt, Gerrie van de Ven, Helias Udo de Haes and Geert de Snoo

Published in Journal of Environmental Management 65 (2002), 269-283

Summary

This article compares four Dutch environmental certification schemes for agricultural food crops, analysing their methodology and the completeness of their criteria on five aspects: pesticide use, nutrient use, water management, energy and materials consumption and habitat management. The least stringent of the labels, the MBT ('Environmentally Aware Cultivation') certificate, serves mainly to increase farmers' awareness of nutrient and pesticide use. With regard to both administrative obligations and actual management practices, the MBT label largely mirrors the terms of standing Dutch legislation. The CC ('Controlled Cultivation') and AMK ('Agro-Environmental') labels comprise more and more stringent criteria. With their restrictions on nutrient and pesticide use, these two labels serve as the two principal labels in the field of integrated agriculture. There is little difference between the two and it is recommended that they be merged, on the basis of a standardised definition of integrated agriculture. The EKO ('Organic Agriculture') label proceeds from different principles, but as a minimum should also comply with Dutch legislation without exception. For both integrated and organic agriculture, in addition to criteria on pesticide and nutrient use, criteria should also be developed for water management, energy and materials use and habitat management. The relationship between the criteria and their respective thresholds and Dutch legislation is also addressed. Existing criteria are frequently specified in such a way that the environmental benefits cannot be ascertained. This is a serious drawback for the parties further down the chain: auctioneers, retailers and consumers. It is recommended to develop qualitative guidelines for an Agricultural Stewardship Council at international level, like the Forest Stewardship Council, and a seperate label for integrated agriculture per country comprising quantitative criteria for all relevant aspects of farming operations.

[1] The term 'environmental labelling' refers to the certification of products. The term 'environmental certification scheme' is used for the certification of farm holdings.

2.1 Introduction

In the past decade a number of environmental certification schemes for agricultural produce have been developed. These initiatives, taken by retailers, food processors, auctioneers and farmers to reduce the negative impact of intensive agriculture on environmental quality and biodiversity, complement legislation in this area. Most of these environmental labels are restricted in scope to on-farm operations.

The first of these, the EKO ('Organic Agriculture') label, was introduced at the European level in 1991 (European Council, 1997). Its principal feature is zero use of artificial fertilisers and chemical pesticides, although several natural pesticides are permitted. After the EKO-label also other labels for farming regimes have been developed in both the US and Europe. Examples of environmental labels are; Stemilt's Responsible Choice (US), the Massachusetts-IPM Partners with Nature (US), the Core Values Program (US) (van Ravenswaay and Blend, 1997), Sainsbury (UK) (ASDA Stores Ltd., 1997), the Swiss Fruit Association's National IP Label (EHI, 1998) and ICA Handlarna (Sw) (ICA Handlarna, 1999). Also in the Netherlands several environmental certificates are in force for farm produce. Of these, the MBT ('Environmentally Aware Cultivation') (MBT, 1999, 2000), AMK ('Agro-Environmental Label') (Stichting Milieukeur, 1998a, 1998b, 2000), and CC ('Controlled Cultivation') label - the last introduced by Albert Heijn supermarket chain (Albert Heijn, 1996, 1999) - are most frequently encountered and are considered here. With their less restrictive criteria for pesticide and nutrient use, these three certification schemes are more readily implemented on conventional farms than the EKO scheme. They enable higher yields to be achieved and, with product prices as they currently stand, greater compliance is in principle possible than in the case of the EKO label. These intermediate farming regimes will be referred to here as integrated agriculture.

Integrated agriculture may be defined as a sustainable, technically advanced form of agriculture which, in comparison with conventional agricultural practice, is associated with lower consumption of energy and other resources and reduced environmental pollution, conserves biodiversity and creates an attractive and varied landscape (adapted from WRR; Van der Weijden *et al.*, 1994). However, this is a qualitative definition that has not yet been adequately quantified, and the criteria and thresholds holding for the various environmental labels currently in use may cover a wide range.

In 1998 the European Parliament adopted a resolution concerning the quality of agricultural produce and food products (European Parliament, 1998), with criteria being set for several aspects of human health and environmental quality. The resolution aims to stimulate the development and improvement of integrated agriculture within Europe. This is also supported by the Common Agricultural Policy-Agenda 2000, one of the largest regional funding initiatives within the EU (Brah and Schelleman, 2000)

A year after the EU-resolution a number of European supermarkets, united in the Euro-Retailer Produce Working Group (EUREP), launched a second initiative, presenting a framework for Good Agricultural Practice (GAP-EUREP). GAP-EUREP defines several key elements for 'best practice' of horticultural production, specifying qualitative guidelines for pesticide and fertiliser use, soil management, irrigation and several other aspects that must be satisfied by farmers supplying EUREP-affiliated supermarkets

(EUREP, 1999). These guidelines are comparable to the directives, defined by the Forest Stewardship Council (FSC Werkgroep Nederland, 2000) on an international level, which is used to set up quantitative criteria per country, like for instance Sweden (Swedish FSC Working Group Secretariat, 1997).

The MBT and CC labels were recently aligned with the GAP-EUREP framework. The comparative status of the four environmental labels considered in this study is reviewed in Figure 1.

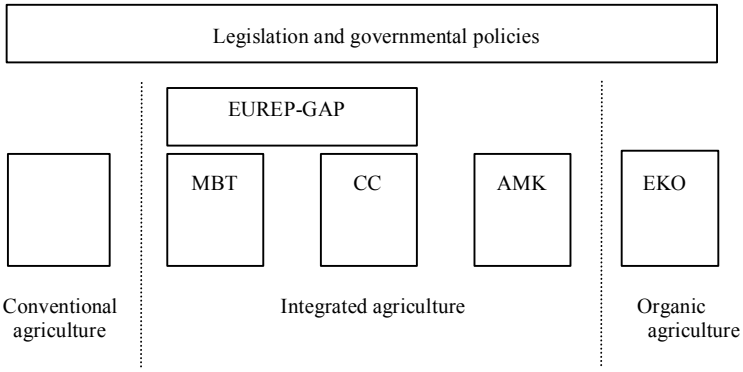

Figure 1. Status of the MBT, CC, AMK and EKO environmental labels relative to Dutch government policy and conventional Dutch agriculture regimes.

Although these two trends, the development of environmental labelling schemes and the European incentive for integrated agriculture, are working in the same direction, the situation is still rather confused. The GAP-EUREP framework is largely qualitative, while the various labelling schemes employ widely differing criteria (de Snoo and van de Ven, 1999). A further issue is whether the labels should be communicated to consumers at the product or the supermarket level.

This article analyses and assesses the criteria and associated threshold values of four Dutch environmental labels in terms of methodology and completeness for five aspects: pesticide use, nutrient use, water management, energy and materials consumption and habitat management. For reasons of comparison, the study is limited to ware potatoes, fruit and vegetables. Conventional agriculture, as practised under the terms of standing Dutch legislation, has been taken for the purpose of reference, although no evaluation of this legislation is attempted here. Having identified the differences between the four environmental labels, their effectiveness is assessed, in relation to the respective criteria and threshold values.

Another important aspect of environmental labelling is the monitoring of the enforcement of these labels in practice. However, with this aspect is not dealt with in this paper, as only the assessment of the environmental labels, in relation to the agricultural production, was investigated.

Also, a framework for integrated agriculture will be proposed, based on the discussed criteria of the environmental labels and the given possible improvements. Although this article is focused on the Dutch situation, the framework developed for integrated agriculture will also be applicable in other countries in Europe, such as Germany, France and Denmark.

2.2 Methodology

Environmental labels in Dutch agriculture
All four environmental labels for food crops considered in this article: MBT ('Environmentally Aware Cultivation'), CC ('Controlled Cultivation'), AMK ('Agro-Environmental Label') and EKO ('Organic Agriculture') operate within the overall constraints of Dutch legislation. Their main features are summarised in Table 1.

Table 1. Main features of the MBT, CC, AMK and EKO environmental labels (+: aspects covered, -: not covered).

	MBT	CC	AMK	EKO
Orientation	product	product	holding, product	holding, product
Aim	sales potential, less pollution	tasty and affordable food, environmentally sound production	environmentally sound production	balanced relationship people/nature/ environment
GAP-EUREP implemented?	yes	yes	no	no
Label visible to:				
- retailer	+	+	+	+
- consumer	+/-	-	+	+
Producer benefits	image, sometimes condition of supply	condition of retailer supply	image	image, higher price
Products (number of species per category)	potatoes vegetables (10) fruit (2)	potatoes vegetables (30) fruit	potatoes vegetables (15) fruit (3) cereals (2)	all products
Environmental themes covered *:				
- climate change	+	+	+	+
- eutrophication	+	+	+	+
- acidification	+	+	+	+
- ecotoxicity	+	+	+	+
- hydrological changes	-	-	-	-
- fragmentation/disturbance	-	-	+	-
- biodiversity	-	-	+	-

* (De Snoo and Van de Ven, 1999)

The MBT product label, developed by farm auction operators, aims to improve sales potential and reduce environmental pollution (Kerngroep MJP-G, 1997). MBT-certified produce meets the aforementioned GAP-EUREP requirements. The trade-oriented MBT label, visible only to retailers; is sometimes specified as a delivery condition by certain retailers and supermarket chains. MBT certification has been elaborated for potatoes,

vegetables and fruits. It uses a credit system, with which farmers have to achieve a minimum number of credits per crop through additional management measures.

The CC product label, introduced by the Albert Heijn supermarket chain (Ahold), aims to guarantee tasty, affordable food produced in an environmentally sound way (Albert Heijn, 1996). The label was recently aligned with the GAP-EUREP criteria. CC certification is a prerequisite for supplying Albert Heijn and the label is not communicated directly to consumers. Criteria and thresholds have been set for potatoes, vegetables and fruits.

The AMK product label, an initiative of the Dutch Ministry of Agriculture, Nature Management and Fisheries, is intended to promote environmentally sound farm production methods (Stichting Milieukeur, 1996). Its scope was recently extended and it now serves as a farm-level label for arable holdings, based on the original product labels for potatoes, vegetables and cereals. Like the MBT label, it employs a credit system whereby farmers can compensate for extra pesticide use, within certain limits, by taking additional measures in other areas (cf. Section 2.3). The AMK label does not conform to the GAP-EUREP framework. AMK certification now covers potatoes, vegetables, cereals and fruit and the AMK logo is visible to supermarket shoppers.

The EKO label, defined in the terms laid down in the European Regulation on Organic Agriculture, aims to achieve a balanced relationship between man, nature and the environment (European Council, 1997). Certification is at farm level, with all products labelled individually for sale in supermarkets and specialist outlets. EKO produce is higher-priced than conventional produce and the EKO label helps give agriculture a better image.

Of the environmental labels considered, only AMK and EKO are administered at the farm level. Both are communicated directly to consumers, moreover, while the other two serve only retailers. Most environmental issues are covered by the AMK label (de Snoo and van de Ven, 1999).

Criteria and thresholds for environmental label comparison

We now turn to the five principal aspects of the farming: pesticide use, nutrient use, water management, energy and materials consumption and management of uncultivated habitat (henceforth, habitat management). For these aspects the present criteria per environmental label will be described and the possible improvements of those criteria will be discussed. This will be followed by an overall assessment of the labels and the presentation of a framework for integrated agriculture based on selected and adjusted criteria of the environmental labels.

As Genetically Modified Organisms (GMOs) are only used in relation to pesticide use on the farm in the Netherlands at this moment, this subject will only be discussed in relation to the management of pesticides.

The criteria of the environmental labels will be considered in terms of administration, spatial layout and management, as relevant. The criteria for administration refer to the detail of on-farm administration required; this may be at the field, plot, crop or holding level. In substance, administration covers use of certain materials, environmental impact

(Section 2.3) and field applications of pesticides (agent and dose in kilograms of active ingredient, AI) and nutrients (kilograms of phosphorus or nitrogen per hectare).

Although the spatial layout of farmland has a major influence on nutrient and pesticide use and habitat management, under current certification schemes the only reference is to establishment of buffer zones. These zones, along the ditch-side margins of productive areas, are designed to reduce the drift of pesticides and nutrients to adjacent waterways. Their width is measured from the top of the ditch bank to the edge of the first row of the crop (Figure 2), ignoring any seasonal fluctuations in water level or differences in ditch bank slope and crop row width, all of which may affect preferred buffer zone width.

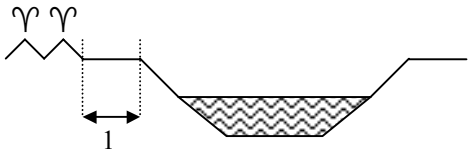

Figure 2. Buffer zone width: (1) distance from crop edge to top of ditch bank.

Management criteria include limitations on the use of pesticides (kg AI) and nutrients and subscriptions for machinery, accessories and cultivation on field, crop or farm level. For nutrients, a 'supply standard' and a 'surplus standard' are distinguished. The former specifies a maximum permissible nutrient input in $kg.ha^{-1}.yr^{-1}$, while the latter sets a ceiling on permitted phosphorus and nitrogen surpluses in $kg.ha^{-1}.yr^{-1}$, calculated as the difference between nutrient input and output at the farm gate on a hectare basis.

2.3 Comparison of the environmental labels

This section first reviews the general legislative context within which Dutch agriculture is practised and then considers the criteria applied under the individual environmental labelling schemes for each aspect of farming, followed by suggestions for improvement of the prescribed criteria.

Conventional agriculture - Dutch legislation

In the Netherlands conventional agriculture is subject to national regulations concerning nutrient use (LNV, 1995), pesticide use (LNV, 1991), water management (V&W *et al.*, 2000) and nature conservation (LNV, 1990; 1997). The first three of these embody farm-level restrictions and obligations (Table 2).

Table 2. Dutch legislation with respect to nutrient use, pesticide use and water management in arable farming (LNV, 1991, 1999; LNV & VROM, 1991; VROM, 1995; V&W *et al.*, 1991; V&W *et al.*, 2000).

	Pesticide use	Nutrient use	Water management
Administration	Limited list of pesticides + 7 'essential' pesticides for which limited application is allowed and administration required	Administration of nitrogen and phosphorus inputs and outputs per holding (MINAS)[1]	Reporting duty for draining
Spatial layout	Cultivation-free zone: for un-intensively sprayed crops 0.25 m (cereals) or 0.50 m (other crops, depending on application method), for intensively sprayed crops 1 or 1.5 m; organic agriculture exempted	Cultivation-free zone: for un-intensively sprayed crops 0.25 m (cereals) or 0.50 m (other crops, depending on application method), for intensively sprayed crops 1 or 1.5 m; organic agriculture exempted	
Management	Use of (inverted) off-centre caps and low-drift nozzles[1] + sprayer boom at 50 cm Application allowed only at low wind speeds (< 5 m/s) Inspection of application equipment every two years Wet and dry fumigation only permitted after licensing between 15/3 and 16/11 No draining/dumping of pesticide- or disinfectant-contaminated waste water allowed No use of surface water for pesticide application equipment allowed	Max. 150 kg N surplus + max. 35 kg P_2O_5 surplus (ha^{-1} yr^{-1}) Max. supply of 85 kg phosphorus (ha^{-1} yr^{-1}) in animal manure on arable land No manure application from 1 or 16 Sept. until Jan. depending on soil type and on frozen or snow-covered soils Low-emission application of manure, except for fruit cultivation, and enclosed storage Prior soil analysis obligatory for application of sewage sludge Limits on heavy metal content of sewage sludge and compost Use of side distributor for artificial fertiliser obligatory along watercourses	Draining of fields allowed under licence Irrigation allowed under licence Complete/temporary prohibition on irrigation, depending on provincial regulations No discharges into surface water allowed within 40 meters of a sewer system, except for relatively unpolluted water Use of groundwater allowed under licence or after exemption by provincial authority

[1] New legislation mandatory from 2001

Pesticide use

Legislation on pesticide use sets restrictions on the kinds of pesticides permitted, the application equipment to be used and the minimum width of buffer zones adjacent to watercourses. Under the terms of the Pesticide Act (1962) pesticide approval is subject to a baseline assessment vis-à-vis efficacy and potential damage to nature, human health and the environment.

Since February 2000 farmers have an obligation to maintain a buffer zone along watercourses (V&W *et al.*, 2000). The width of the zone varies from 0.25 to 1.50 metres, depending on the equipment used and the type of crop treated (intensively vs. unintensively sprayed crops). The use of (inverted) off-centre caps and low-drift nozzles is to become mandatory in 2001. Pesticide application is only allowed at low wind speed (less than 5 m/s). Fumigation, mainly for nematode control, is permitted only once every four years (from 2001, once every five years), and only after urgency of treatment has been demonstrated by soil analysis.

To prevent pollution of surface waters, such water may not be employed for filling pesticide application equipment without use of a buffer vessel or one-way valve. Similarly, no draining of wastewater contaminated with pesticides or disinfectants is permitted.

Nutrient use

Since 1998 a mineral administration system (MINAS) has been operational in the Netherlands. Farmers are obliged to register nitrogen and phosphorus inputs and outputs, measured at the farm gate, if a) the input of organic manure exceeds the legal 'supply standard' (85 kg phosphorus ha^{-1} for arable land) or b) the stocking rate of cattle exceeds the standard of 0.5 cows ha^{-1} or equivalent. From 2001 onwards, MINAS will also be mandatory for arable farming and horticulture; until then, the supply standard remains the only restriction.

Under the MINAS scheme the difference between nitrogen and phosphate inputs and outputs is calculated at the farm gate, to give the actual surplus on a hectare basis; if this exceeds the 'surplus standard' (Table 2) a levy must be paid.

In terms of spatial layout, an uncultivated buffer zone is prescribed around crops, adjacent to watercourses, which may not be fertilised; in addition, use of a side distributor for artificial fertiliser (which prevents deposition of fertiliser to the ditch) is obligatory. The width of the zone varies from 0.25 to 1.50 metres, depending on the type of crop (see pesticide use). Application of manure is allowed in a certain period only (Table 2) and a low-emission application method must be employed. Application of sewage sludge is allowed only after analysis has shown the heavy metals content of the sewage to be below a certain limit.

Water management, energy and materials consumption

With respect to water management, only a few laws relate directly to farm operations. The draining of fields to improve the hydrological regime requires a licence, as does the use of surface water for irrigation purposes. In some provinces regulations have been introduced prohibiting irrigation, or restricting it to certain periods. Draining of wastewater to surface waters is not permitted, unless there is no sewer present within 40 metres. Use of groundwater for irrigation requires a licence, or, in some provinces, exemption from regulations.

There are no legislative restrictions on energy consumption. With regard to materials consumption, separate waste collection is compulsory for agricultural sheeting and several other materials.

Habitat management

The principal aim of Dutch conservation legislation is to preserve the natural values and landscape elements of the National Ecological Network (NEN) (LNV, 1990), which encompasses only a limited part of the Netherlands. Besides this legislation there is also a policy on species protection, based on the 'Red List' of endangered and vulnerable species

(LNV, 1990). These two policies do not impinge directly on farmers, although endangered species encountered on farms must be protected.

Within the bounds of the NEN, farmers and landowners receive government support for conserving and managing natural areas and landscapes (LNV, 1997). Under the terms of a voluntary habitat management scheme, farmers are rewarded for implementing farm-level habitat management measures (DLG, 2000).

Dutch environmental labels

Pesticide use

Table 3 reviews the criteria for pesticide use for each of the environmental labels.

Present criteria

No administration of natural and/or chemical pesticide use is yet prescribed under the EKO label or Dutch legislation, but in the course of 2000 monitoring of total annual pesticide use is to become mandatory for vegetables. For the other labels, pesticide administration varies from registering applications per crop (CC and AMK) to applications per field (MBT). For the AMK label the farmer must also register the potential environmental impact of the pesticides used (formulated in terms of credits per product, see below) and total farm-level purchases. Under all environmental labels except EKO, pesticides used must be identified by name and the dose per application registered.

The buffer zone adjacent to running watercourses prescribed under Dutch legislation is respected by MBT, CC and AMK. EKO forms a legal exception, as no buffer zones are prescribed, even though natural pesticides are allowed. Based on the criterion for the maximum permitted dose (kg AI ha^{-1}) per crop (henceforth, AI standard) and mandatory use of low-drift application equipment, AMK farmers may be permitted by the local District Water Board to implement reduced buffer zones of 0.50 and 0.75 m, respectively, for potatoes and carrots.

The MBT label tolerates all the pesticides approved for use in the Netherlands, while CC and AMK allow the use of selected pesticides, assessed on the basis of an 'environmental yardstick'. With the 'environmental yardstick' the pesticides are assessed on leaching to groundwater, persistence in soil and toxicity to aquatic and soil organisms (IKC, 1996).

The EKO label tolerates zero use of chemical pesticides; if there is an acute threat to the crop, use may be made of a small number of EU-approved natural pesticides. Under the AMK scheme, farmers must draw up an annual crop protection schedule for each crop that conforms to the AI standard. The CC label prescribes a minimum length of crop rotation for potatoes and vegetables.

Only with the EKO label is the use of Genetically Modified Organisms (GMOs) for crop protection forbidden; the other labels have no restrictions on this point.

Chemical fumigation and aerial application of pesticides are allowed only in conventional agriculture and MBT.

Table 3. Criteria for pesticide use in arable farming under Dutch legislation and the MBT, CC, AMK and EKO labels (=: as per legislation, +: better than legislation, +/-: farmer's discretion, ≠: prohibited, -: not used) (MBT, 1999, 2000; AH, 1996, 1999; Stichting Milieukeur, 1998a, 1998b, 2000; European Council, 1997).

	Criteria	Legislation	MBT	CC	AMK	EKO
Administration	Per field (kg AI ha^{-1})	-	+	-	+	-
	Per crop (kg AI ha^{-1})	-	+[1]	+	+	-
	Treated area (kg AI ha^{-1})	-	+	-	-	-
	Per holding purchase (kg)	-	-	-	+	-
	Per application: product + dose (kg AI ha^{-1})	-	+	+	+	-
	Credits of environmental impact	-	-	-	+	-
	Frequency of administration	-	daily	-	2-weekly	-
Spatial layout	Buffer zone as per legislation	compulsory	=	=	=[4]	-
Management	Use of chemical pesticides as per legislation	allowed	=	≠	≠	≠
	Use of limited number of chemical pesticides, based on 'environmental yardstick'	-	-	+	+	≠
	Use of natural pesticides	allowed	=	-	-	-
	Use of limited number of natural pesticides	-	-	-	-	+[3]
	Crop protection plan	-	-	-	+	-
	Rotation scheme, potatoes	-	-	1 per 3 or 4 yr.	-	-
	Rotation scheme, vegetables	-	-	2 per 3 yr.	-	-
	Use of gmos	-	-	-	-	≠
	Fumigation	allowed	=	≠	≠	-
	Aerial application	allowed	=	≠	≠	-
	Chemical treatment of problem weeds in buffer zone	allowed	=	≠	=	=
	Max. kg AI ha^{-1}, potatoes (early-late)	-	-	8-10 kg	6 kg[2]	-
	Max. kg AI ha^{-1}per vegetable:					
	- cauliflower and broccoli	-	-	6 kg[1]	1 kg[2]	-
	- green and dwarf beans	-	-	2.5 kg[1]	2 kg[2]	-
	- leek, early and late	-	-	6-11 kg[1]	6-6 kg[2]	-
	- red beet	-	-	4 kg	2.5 kg[2]	-
	- headed cabbage	-	-	2 kg[1]	2 kg[2]	-
	- onion	-	-	10 kg	13 kg[2]	-
	- carrot, summer and autumn/winter	-	-	4.5-7.5 kg	2.5 kg[2]	-
	Credit system	-	+	-	+	-

[1] no herbicides allowed
[2] extra AI allowed for stubble control and some agents allowed outside AI-limitation
[3] allowed only if crop is acutely threatened
[4] buffer zones of 0.50 and 0.75 m allowed for potatoes and carrots, respectively, after permission from the District Water Board

Use of the herbicide glyphosate to control problem weeds in the buffer zone, like *Elytrigia repens*, *Petasites hybridus* and *Cirsium arvense*, is permitted under MBT and AMK.

MBT sets no limits on pesticide use. For some crops, CC and AMK have annual restrictions on total AI: the AI standard, as indicated in Table 3. For most crops, the AMK AI standard is more stringent than the CC variant. Besides imposing an AI standard, CC also prohibits herbicide use on certain crops.

In tandem with the AI standard, AMK administers a credit system that makes due allowance for the environmental impact of the particular pesticides used, measured with

reference to the 'environmental yardstick'. At the beginning of each year, for each crop cultivated farmers receive a number of credits per hectare, and for each application of an 'environmentally critical' pesticide credits are deducted according to its potential impact. Three categories of pesticide are distinguished: 1) not 'environmentally critical': no deduction of credits; 2) very 'environmentally critical': deduction of 2 credits per application; 3) other pesticides: deduction of 1 credit per application. A negative score is acceptable, as long as the AI standard is respected, but the farmer must then compensate by using drift-reducing equipment, establishing broader pesticide/nutrient buffer zones, using 'green' electricity and/or implementing specific habitat management measures.

Possible improvements

Although farm-level administration of pesticide use is a good first step, administration per field, combined with administration of pesticide environmental characteristics, can increase farmer awareness of pesticide use and the associated potential environmental impact, thus helping to reduce use of both natural and chemical pesticides. For all environmental labels, then, not only should the AI inputs be registered but also the potential environment impact; this is now only the case under AMK.

The compulsory buffer zone should be extended to other types of habitat, such as hedgerows and verges, to reduce the impact of both natural and chemical pesticide drift on biodiversity. A minimum drift reduction of 95% can only be achieved with a buffer zone at least 3 metres wide (de Snoo and de Wit, 1995; Haycock *et al.*, 1996). This might therefore serve as a good threshold for a standardised environmental label.

A better way to assess the optimum buffer zone width is by means of a pesticide-specific risk analysis, encompassing type of pesticide, application method and environmental impact. The Local Environmental Risk Assessment for Pesticides (LERAP) approach used in the UK (MAFF, 1999) employs different buffer zone widths, based on two groups of pesticides and methods of application.

The most objective approach would be to determine buffer zone width for each active ingredient separately, but this is not a feasible option. A more realistic strategy would be to establish a buffer zone width for each individual crop, preferably in combination with a method like LERAP.

Having been assessed by the 'environmental yardstick' the pesticides allowed for usage by CC and AMK probably have less environmental impact than other nationally approved pesticides (IKC, 1996). However, the yardstick does not cover all environmental compartments, ignoring emissions to air, for example. Neither are such aspects as toxic accumulation in the food chain accounted for (de Snoo and de Jong, 1999).

Criteria should be defined, which take into account the environmental claims and the potential environmental impacts of the GMOs.

An all-out ban on fumigation would be a great improvement because of the major environmental impact of fumigants associated with their use as fungicides, herbicides and nematicides (van Rijn *et al.*, 1995). Gaseous fumigants and water-soluble granulates cause atmospheric emissions and leaching to ground and surface waters, respectively (Horeman and Wottiez, 1996). Broader-based crop rotation and use of resistant crop varieties can render soil fumigation redundant. Hence, an overall ban on fumigation appears feasible in

the near future. With aerial pesticide application, large drift is to be expected (CTB, 1997). Switching to field application substantially reduces drift.

The use of a hand-held sprayer reduces the benefits accruing from the zone. Although it reduces drift, there is still a risk of emissions to watercourses. Application of pesticides in the buffer zone should therefore be banned completely, with any problem weeds being removed mechanically or by hand.

The crop-specific AI standard (in kg ha^{-1} yr^{-1}) in force for AMK in combination with the limited list of AMK-approved pesticides may be a rather strict criterion, but compliance is generally feasible. In the event of high weed pressure, on cereal plots for example, adherence to the AI standard may be unfeasible (Salomons *et al.*, 1999). In such cases it is allowed to exceed the standard by 25%, provided this is offset by reductions on other crops. Such compensation leads to AI-standard pesticide use at the farm level, even though the standard is exceeded at the field level.

In comparison with conventional agriculture, on average AMK cultivation uses 75% less AI and has only 2% of the environmental impact, as gauged on the 'environmental yardstick' (de Jong and de Snoo, 2002). The differences between conventional and AMK agriculture relate to the types and amounts of pesticides used and the drift reduction measures adopted.

This credit system is very complex and the option of compensating pesticide use with credits earned for other management activities substantially reduces the transparency of the system, especially as every farmer has a different pesticide application schedule.

Under the EKO scheme there is little pesticide use or dependency and this is restricted to natural pesticides (de Vries *et al.*, 1997). Even the natural pesticides used in organic agriculture may cause environmental problems, however. Examples include excessive use of sulphur and copper in fruit and vegetable cultivation. No direct environmental effects are known to be associated with sulphur (de Vries *et al.*, 1997) but further research is necessary. Use of copper compounds poses a risk to the environment above a certain level, which may be reached due to accumulation in the soil (RIVM, 1998). Even mechanical weed control is associated with several drawbacks, while intensive soil tillage disturbs soil life, compacts soils and is likely to disturb nesting birds.

For all labels it is recommended that, in addition to restricting the number of pesticides admitted, criteria and thresholds should also be adopted vis-à-vis anticipated local environmental impact. The 'environmental yardstick' is available for this purpose, although it must be extended to cover additional aspects, as outlined above.

Nutrient use

Present criteria

The most common criterion for nutrient use (Table 4) is the administration of the amount of phosphorus and nitrogen used on the farm, as similar for all three 'integrated' labels. All farm inputs and outputs and specific applications must be registered on an annual basis, the latter either at crop or field level (per hectare). Only in the case of CC is administration of potassium inputs required. For the EKO label, no administration is required. For nutrient application the width of the buffer zone is similar to that required for pesticide application.

MBT and CC conform to national legislation and, again, AMK has a narrower buffer zone for potatoes and carrots, while EKO is exempted. EKO, in contrast to legislation and the MBT, CC and AMK labels, prohibits the use of artificial fertiliser. An advance annual fertiliser schedule is compulsory for CC and AMK.

On farms with fewer than 0.5 cows ha^{-1} there is as yet no legal restriction on nitrogen fertiliser use, while for phosphates only a 'supply standard' is prescribed. The government is to introduce N and P 'surplus standards' in 2001 and until then a recommended nutrient application is in force based on soil type, mineralization, deposition, fixation, crop and crop rotation. AMK already adheres to the N and P surplus standards, while MBT respects only the second of these. CC instead uses the crop-specific N surplus standards, which are derived from the scheduled government general surplus standard for arable farming.

Table 4. Criteria for nutrient use in arable farming under Dutch legislation and the MBT, CC, AMK and EKO environmental labels (= : as per legislation, +: better than legislation, +/-: farmer's discretion, ≠: prohibited, -: not used) (MBT, 1999, 2000; AH, 1996, 1999; Stichting Milieukeur, 1998a, 1998b, 2000; European Council, 1997).

	Criteria	**Legislation**	**MBT**	**CC**	**AMK**	**EKO**
Administration	Nitrogen (kg N ha^{-1})	-	+	+	+	-
	Phosphorus (kg P ha^{-1})	-	+	+	+	-
	Potassium (kg K ha^{-1})	-	-	+	-	-
	Artificial fertiliser (kg N, P, K ha^{-1})	-	+	+	+	-
	Animal manure (kg N, P ha^{-1})	-	+	+	+	-
	Per field (total kg N and P)	-	+	-	+	-
	Per crop (total kg N and P)	-	+/-	+	+	-
	Purchase per holding (total kg N and P)	-	-	-	+	-
	Total use per holding	-	-	-	+	-
	Per application	-	+	+	+	-
	Frequency of administration	-	weekly	-	4-weekly	-
Spatial layout	Buffer zone as per legislation	compulsory	=	=	=[4]	-[3]
Management	Use of artificial fertiliser	allowed	=	=	=	≠
	Use of natural fertiliser	allowed	=	=	=	=
	Fertiliser plan	-	-	+	+	-
	Cd-content < 20 mg per kg phosphorus	-	-	-	+	-
	P-application as function of P_w-value	-	-	+	+	-
	Exceeding of P surplus standard (MINAS)	-[1]	+/-[5]	-	+[2]	-
	Exceeding of N surplus standard (MINAS)	-[1]	-	-	+[2]	-
	Crop-specific N surplus standard	-	-	+	+	-
	Exceeding of P-supply standard (MINAS)	not allowed	=	=	=	=
	Compliance with field-specific recommended N-application or with N-surplus standard at rotation level, differentiated per crop	-	-	-	+	-
	N-surplus standard per crop	-	-	+	+	-
	Potassium application based on K-value	-	-	+	-	-

[1] new mandatory regulations for arable farming from 2001
[2] exceeding of the standard is not allowed and leads to label exclusion
[3] exception in the legislation for buffer zones
[4] a buffer zone of 0.50 and 0.75 m is allowed for potatoes and carrots, respectively, after permission from the District Water Board
[5] part of the MBT credit system

Under AMK the farmer can opt for the government's recommended nitrogen application or the farm-level surplus standard (MINAS). CC prescribes the former option, only specified per crop.

For AMK and CC, permitted phosphorus application is related to the amount of water-soluble phosphate in the soil (P_w-value), which must be measured every four years. This is similar to adhering to the government's 'recommended application'.

The AMK label also restricts the cadmium content of animal manure to a maximum of 20 mg Cd per kilo phosphorus.

Possible improvements

In 2001 the Dutch government is to introduce mandatory rules for nutrient registration, based on the MINAS 'surplus standards' for arable farming, but probably only at the farm level, as is currently the case for intensive animal husbandry. To enable proper comparison, registration should be standardised at the field level, as presently implemented under the MBT, CC and AMK schemes.

With respect to the optimum buffer zone width for preventing leaching of nitrogen and phosphorus to surface waters, the same critical remarks can be made as for pesticides. As yet, however, no quantitative relationship has been established between buffer zone width and leaching characteristics. Based on soil type, hydrology and vegetation, an optimum buffer zone should be determined for both nitrogen and phosphate (STOWA, 1998). Until then a 3-metre buffer zone is proposed, in line with that recommended for pesticide use.

Farm fertiliser schedules provide a good synopsis of fertiliser use in relation to crop rotation and allow nutrient applications to be fine-tuned to the needs of the current and following crop. For phosphorus, especially, application based on a crop rotation scheme may help reduce inputs.

The surplus standards for nitrogen is soon to be introduced under MBT.

The AMK choice of opting for MINAS instead of the government's 'recommended nitrogen application' should be eliminated, as MINAS neglects nitrogen deposition and fixation aspects (Schröder, 1999). The surplus standard allows fertiliser to be transferred between fields within the farm. The surplus standard may thus be locally exceeded, because final administrative calculations are for the farm as a whole.

Without any need for further requirements, all EKO farmers already operate in line with the legislation for 2000 and in most cases even the stricter limits for 2003. Given the fact that more nitrogen is lost from organic manure than from artificial fertiliser, sound farm management is of the essence. Unfortunately, the phosphorus standard is not readily met on EKO farms (de Vries *et al.*, 1997).

Appropriate nutrient inputs should be determined for each individual crop in relation to soil type, mineralization, N-deposition, N-fixation, hydrology and timing of crop growth and land cultivation, all of which influence the crop availability of nitrogen and phosphorus and the losses to the environment. Fine-tuning to allow for local soil variations should reduce nitrogen and phosphorus surpluses in soils and ground and surface waters.

It is not entirely clear whether toxic impact is sufficiently limited in practice. Because of the extensive use of animal manure in organic agriculture, cadmium accumulation and nitrate leaching also constitute a problem with the EKO label (de Vries *et al.*, 1998).

Water management, energy and materials consumption

Present criteria

Like habitat management, water management and energy and materials consumption are addressed only incompletely by the AMK label, and then mainly via measures already implemented voluntarily under the credit scheme, like administered water management, irrigation according to a recommended irrigation scheme or empirical measurement (tensiometer or soil analysis) and use of 'green' electricity. The only restrictive criteria for AMK concern separate (inorganic) waste collection and rinse water processing, and even these are neglected by the other environmental labels.

Further down the food production chain, CC addresses materials use by setting ceilings on use of packaging materials.

Possible improvements

To address these environmental issues water, energy and materials use should be monitored and criteria formulated as relevant.

Habitat management

Present criteria

Habitat management is an aspect of farm management addressed only obliquely, if at all, by the environmental labels (Table 5). Only AMK and MBT have criteria in this point, and these are voluntary.

Table 5. Criteria for habitat management under Dutch legislation and the MBT, CC, AMK and EKO environmental labels (=: as per legislation, +: better than legislation, +/-: farmer's discretion, ≠: prohibited, -: not used) (MBT, 1999, 2000; AH, 1996, 1999; Stichting Milieukeur, 1998a, 1998b, 2000; European Council, 1997).

		Legislation	MBT	CC	AMK	EKO
Administration	Farm-level conservation plan	-	+/-[2]	-	+/-[2]	-
Spatial layout	Buffer zones along watercourses	compulsory[1]	=	=	=	-[1]
	Wildflower borders	-	+/-[2]	-	-	-
	Farm-level conservation plan	-	+/-[2]	-	+/-[2]	-
	Nesting boxes for owls and falcons	+/-	+/-[2]	-	+/-[2]	-
	Nesting boxes for insectivorous birds		+/-[2]	-	-	-
	(Creation of) landscape-enhancing habitats (region-specific)	-	+/-[2]	-	+/-[2]	-
Management	Farm-level conservation plan	-	+/-[2]	-	+/-[2]	-
	Field margin management	+/-	-	-	+/-[2]	-
	Sound habitat management	-	+/-[2]	-	-	-
	Chemical treatment of buffer zones	not allowed	=	=	=	-
	Encouragement of natural predators	-	-	-	+/-[2]	-
	Management of meadow birds	-	+/-[2]	-	+/-[2]	-

[1] except for EKO

[2] part of the credit systems of, respectively MBT or AMK

None of the labels employ administration of habitat management criteria, although in the case of AMK and MBT farmers may adopt a voluntary conservation plan based on scheduled measures (see below).

All environmental labels except EKO prescribe a buffer zone along watercourses.

As stated, AMK and MBT farmers may adopt a voluntary conservation plan or installing nesting boxes for owls and falcons, with which they earn credits. In the case of AMK these credits may be used to compensate for pesticide use, within the limitations of the AI standard; protection of valuable habitats and plants of regional origin are likewise credited. Under the MBT scheme, creation and management of valuable landscape elements (such as hedges) are also rewarded.

Under the AMK and MBT labels, compliance with habitat management criteria is purely voluntary, with farmers free to adopt conservation-friendly field margin management regimes, encourage meadow birds nesting on the farm or natural predators in the fields (thus to reduce pesticide use), or draw up an integrated conservation plan for the entire holding. Under the AMK scheme, the credits thus earned can be used to compensate for pesticide use; with MBT these credits go towards the minimum number required to qualify for the label. The other labels have no such provisions. The MBT and AMK schemes also include specific measures for bird protection; the other labels do not consider any specific species group.

Possible improvements

If a certificate includes criteria for habitat management, administration is essential, for the purpose of monitoring scheduled and implemented measures.

As a following step to preserving and improving nature qualities, buffer zones should be extended to other types of habitat like hedgerows.

Conservation plans under AMK should also examine the potential for extending habitats in specific response to the local landscape and regional habitat types. There is also greater scope for implementing species-specific measures, again in response to local landscapes and habitats. For a more detailed proposal on conservation-oriented farm management and the spatial configuration of uncultivated habitats, readers are referred to de Snoo and van de Ven (1999).

The habitat management measures currently recommended under the AMK scheme are imprecisely formulated. For each specific habitat, management guidelines should be laid down in order to avoid inappropriate management regimes. In addition, management guidelines should be prescribed for species groups other than birds.

As the AMK label is administered at the farm level, ‘added value’ could be achieved by introducing more restrictive, compulsory measures for habitat management, such as earmarking 5% of the overall holding for conservation. The same holds for EKO, the other farm-level label, and habitat management guidelines are indeed being developed here, based on a conservation plan for the entire holding (Smeding, 1995).

2.4 Overall assessment of the environmental labels

All the environmental labels focus primarily on the same two aspects of pesticide and nutrient use, although in some cases there is also limited coverage of other aspects. For these two aspects, criteria and thresholds are set for administration, spatial layout and overall farm management. In most cases the criteria are merely qualitative, with quantitative thresholds an exception. Most of the criteria for pesticide and nutrient use are derived from standing Dutch legislation.

The MBT environmental label is to be regarded merely as a tool for improving farmers' awareness of their pesticide and nutrient use, with no limitations being imposed over and above legislative ceilings. Following a period of compliance with the MBT scheme, farmers may be expected to progress to a more stringent label.

The CC and AMK environmental labels have more strictly defined criteria and thresholds, particularly for pesticide use. With respect to nutrient use, the criteria for these two labels are in line with upcoming legislation. AMK is the only label to consider the aspects of water management, energy and materials use and habitat management, and then largely on a voluntary basis.

There are only minor differences between the CC and AMK labels for integrated agriculture, the two main aspects (nutrient and pesticide use) receiving similar treatment. It is therefore recommended to merge these labels. Although AMK is broader in scope, with some consideration also being given to water management, materials/energy consumption and habitat management, the added value is minimal, as most of the additional measures are voluntary. In the proposed merged label, it is recommended to introduce obligatory measures vis-à-vis habitat management, water management and energy/materials consumption.

Many of the thresholds currently in force lack adequate scientific underpinning vis-à-vis ecological and environmental processes and further research is required here. The same holds for the question of how far thresholds should be differentiated to account for local environmental variations.

2.5 Framework for certification of integrated agricultural companies

In the preceding discussion the criteria and thresholds for the four environmental labels were compared and, on most aspects, proposals for best practice made: how criteria are to be defined, and preferred threshold levels. On this basis a framework for development of a single environmental label for integrated agriculture (Table 6) can now be presented. As can be seen from Table 6, some aspects are not (fully) covered. New or supplementary research is required on a number of issues, as outlined for each aspect below.

In the case of pesticide use, most criteria are clearly defined. However, actual environmental improvements still remain unclear. Improvements should therefore be empirically documented as a function of type of pesticide, buffer zone and so on, using the 'environmental yardstick' or other available tools. This may result in a modification of current threshold values.

Table 6. Proposed criteria and thresholds for a single label for integrated agriculture for pesticide use, nutrient use, water management, energy and materials consumption and habitat management.

	Pesticide use	Nutrient use	Water management	Energy and materials consumption	Habitat management
Administration	All natural and chemical pesticides Every application, per crop and per field: - product - quantity (kg AI ha^{-1}) - environmental impact	Nitrogen, phosphate and potassium Every application, per crop and per field: - type of fertiliser - quantity (kg ha^{-1})	Administration of groundwater and rainwater use	Administration of materials and energy consumption	Administration of scheduled and implemented management measures
Spatial layout	Compulsory buffer zone along cultivated areas, for all relevant habitats Compulsory buffer zone for use of natural and chemical pesticides Min. width of buffer zone: 3 m, or based on specific crop or pesticides used	Compulsory buffer zone along cultivated areas, for all relevant habitat, with a minimum width of 3 metres	-	-	Compulsory buffer zone along cultivated areas Minimum percentage area of natural habitat on farm (e.g. 5%) Wildflower border Nesting boxes Creation of landscape-enhancing planted areas
Management	Admission of pesticides based on: - leaching to ground water - emissions to air - acute toxicity to aquatic and soil organisms - risk of bio-accumulation - prohibition of fumigation - prohibition of aerial application - no pesticide treatment of problem weeds in the buffer zone Standard maximum kg AI ha^{-1} per crop, based on: - leaching to ground water - emissions to air - acute toxicity to aquatic and soil organisms - risk of bio-accumulation	Artificial and natural fertiliser permitted Annual fertiliser plan based on rotation plan Nitrogen application based on: - type of fertiliser - crop and rotation plan - soil type - hydrology - soil storage: Nmin.[1] - mineralization during grow season - N-fixation/N-deposition Phosphate application based on: - type of fertiliser - crop and rotation plan - soil type/hydrology - soil storage: P_w-value	Irrigation according to irrigation plan	Use of 'green' electricity	Farm-level conservation plan Field margin management Sound habitat management No chemical treatment of buffer zones or other habitats Encouragement of natural predators Management of meadow birds

[1] minimal nitrogen storage in soil in spring

With respect to nutrient use, the prescribed width of buffer zone should be based on local soil type, hydrology and vegetation. Until the optimum width of buffer zone has been quantitatively assessed, it is proposed to adopt the 3-metre buffer zone currently enforced for pesticides. Fine-tuning nutrient applications to the factors indicated in Table 6 can further limit nutrient leaching to ground and surface waters.

In the case of water management, groundwater dependency can be reduced by making greater use of the potential for on-farm water retention and storage. Greater restrictions must also be imposed on crop irrigation, with permitted regimes classified according to specific crop requirements, time of irrigation and so on.

With regard to farm materials use, recycling and re-use can limit the quantities consumed. Depending on the available options, a certain amount of administration is unavoidable. On the issue of energy consumption, it is important that 'green' sources of energy such as wind and solar are explored in relation to on-farm application.

When it comes to habitat management, the preferred option appears to be specification of a minimum percentage farm area left uncultivated. This may well be in the order of 5% (Smeding, 1995). Differentiation among different types of farm should also be considered. Moreover, a clearer definition of 'uncultivated habitats' is required.

Although the basic terms of the proposed framework are fairly clear, appropriate criteria with exact thresholds must now be formulated for all the diverse aspects on the farm level, with the aim of further reducing the environmental impact of agriculture as far as possible. This calls for a more detailed research programme.

2.6 Conclusions

The environmental labels analysed show a varied pattern. Compared with the CC and AMK labels, MBT is a poor actor on the integrated agriculture stage. In practice, MBT serves as a first step towards integrated agriculture, as prescribed by the more stringent schemes CC and AMK. These two labels employ similar criteria for both pesticide and nutrient use, tackling the issue in broadly parallel fashion, but largely neglect the aspects of energy and materials consumption, habitat management and water management.

With its zero tolerance of artificial fertilisers and pesticides, the EKO label is exceptional on this score. However, this does not necessarily mean that EKO produce is in all respects more 'environmentally friendly' than crops grown under the two integrated agriculture labels.

In response to growing consumer awareness of the environmental impact of agriculture, all environmental labels are still in the process of development and the GAP-EUREP can be seen as a first initiative to develop guidelines on an international level for agriculture. Therefore, it seems logical to propose qualitative principles for agriculture on an international level as an Agricultural Stewardship Council, referring to the Forest Stewardship Council. Then per country, as a supplement to the EKO label, a single, standardised label for integrated agricultural farms should be developed, based on the most recent scientific understanding of the environmental hazards of all the varied aspects of agricultural systems.

References

Albert Heijn, 1996. Milieunormen voor aardappelen en vollegrondsgroenten “Op weg naar een duurzame landbouw”. Albert Heijn, Zaandam.

Albert Heijn, 1999. Milieunormen voor aardappelen, groenten en fruit. Albert Heijn, Zaandam.

ASDA Stores Ltd., CWS Ltd., Somerfield Stores Ltd., Marks and Spencer plc., the NFU, safeway Stores plc., J. Sainsbury and Waitrose Ltd., 1997. NFU-Retailer ICM Protocol for Fresh Market Potatoes.

Brah, N., Schelleman, F., 2000. Green purchasing in the field of Agri-food. Background paper for EPE’s hearing the field of Green Purchasing of Agri-Foodstuff. Grontmij Water and waste management, The Netherlands. Source: www.epe.be.

CTB (Centraal Bureau Toelating Bestrijdingsmiddelen), 1997. Regeling Uitvoering Milieutoelatingseisen Bestrijdingsmiddelen. Bijlage VII (draft). Board for the Admission of Pesticides, Velp.

DLG (Dienst Landelijk Gebied), 2000. Subsidieregeling agrarisch natuurbeheer. DLG, Utrecht

Europian Parliament, 1998. Landbouw en levensmiddelen, een resolutie over een kwaliteitsbeleid voor land-bouwproducten en levensmiddelen. A4-0280/98.

EHI (EuroHandelsinstituts e. V.), 1998. Fruit and Vegetables from Flanders Integrated Crop Management Fruit and Vegetable. DHI Germany.

EUREP (Euro-Retailer Produce Working Group), 1999. GB-GAP Protocol 2000. Eurohandelsinstitute e.V., Cologne.

European Council, 1997. Council Regulation (EEC) No. 2092/91 on organic production of agricultural products and indications referring hereto on agricultural products and foodstuffs (OJ L 198, 22.7.1991; Bull. 6-1991), as last amended by Regulation (EEC) No 1488/97: OJ L 202, 30.7.1997.

FSC Werkgroep Nederland, 2000. FSC/NL Eindversie Nederlandse FSC standaard voor de certificering van goed bosbeheer. Wageningen. (Source: www.knbv.nl/knbv/home/fscnl.html)

Haycock, N.E., Burt, T.P., Goulding, K.W.T., Pinay, G., 1996. Bufferzones: their processes and potential in water protection. Quest Environmental United Kingdom.

Horeman, G.H., Wottiez, R.D., 1996. MJP-G emissie-evaluatie 1995 Achtergronddocument. Dutch Ministry of Agriculture, Nature Management and Fisheries (LNV) and IKC-Landbouw, Ede.

ICA Handlarna, 1999. ICA Handlarnas AB Annual Report 1999. (Source: www.ica.se)

IKC, 1996. Achtergronden van de milieumeetlat voor bestrijdingsmiddelen. Informatie en Kennis Centrum, Kerngroep MJP-G, Wageningen.

Jong, F. M. W. de, Snoo, G. R. de, 2002. A comparison of the environmental impact of pesticide use in integrated and conventional potato cultivation in the Netherlands. Agriculture, Ecosystems and Environment 91, 5-13.

Kerngroep MJP-G, 1997. Milieumerken in de akker- en tuinbouw op een rij. Veenman Drukkers Wageningen, the Netherlands.

LNV (Dutch Ministry of Agriculture, Nature Management and Fisheries), 1990. Natuurbeleidsplan - Regeringsbeslissing. SDU, Den Haag.

LNV (Dutch Ministry of Agriculture, Nature Management and Fisheries), 1995. Informatie Mest en Ammoniak Beleid.. SDU, Den Haag.

LNV (Dutch Ministry of Agriculture, Nature Management and Fisheries), 1997. Programma Beheer, Het beheer van natuur, bos en landschap binnen en buiten de Ecologische Hoofdstructuur. SDU, Den Haag.

LNV (Dutch Ministry of Agriculture, Nature Management and Fisheries) and VROM (Dutch Ministry of Housing, Spatial Planning and Environment), 1991. Meerjarenplan Gewasbescherming. SDU, Den Haag.

LNV (Dutch Ministry of Agriculture, Nature Management and Fisheries) and VROM (Dutch Ministry of Housing, Spatial Planning and Environment), 1999. Algemene Regeling voor Landbouwkundige Onmisbaarheid. SDU, Den Haag.

MAFF (British Ministry of Agriculture, Fisheries and Food), 1999. Local Environmental Risk Assessments for Pesticides, A Practical Guide. MAFF, London.

MBT (Milieubewuste Teelt), 1999. MBT-richtlijnen vollegrond en aardappelen 1999. Stichting Certerra, Zoetermeer.

MBT (Milieubewuste Teelt), 2000. Concept MBT-richtlijnen 2000 vollegrond. Stichting Certerra, Zoetermeer.

Porskamp, H.A.J, Michielsen, J.M.G.P., Huijsmans, J.F.M., Zande, J.C. van de, 1995. Emissiebeperkende spuitechnieken voor de akkerbouw. De invloed van luchtondersteuning, dopkeuze en teeltvrije zone op de emissie buiten het perceel. Report 95-19, IMAG-DLO, Wageningen.

Ravenswaay, E.O. van, Blend, J., 1997. Using ecolabelling to encourage adoption of innovative environmental technologies in agriculture. Staffpaper No. 97-19 Michigan state University, Michigan US.

RIVM (Dutch National Institute of Public Health and the Environment), 1998. Milieubalans 98. Samson H. D. Tjeenk Willink bv, Alphen aan de Rijn.

Rijn, J.P. van, Straalen, N. M. van, Willems, J., 1995. Handboek bestrijdingsmiddelen gebruik & milieu-effecten. VU Uitgeverij, Amsterdam.

Salomons, J., Arts, E., Kreupeling, J., 1999. Ontwikkeling Agro-Milieukeur 1996-1998 Eindverslag. Stichting Milinova Zeewolde.

Schröder, J., 1999. MINAS: van goed idee tot papieren tijger. In: H_2O 18, 23-24.

Smeding, F.W., 1995. Protocol natuurplan. Mededeling van de vakgroep Ecologische Landbouw 002.95, Wageningen.

Snoo, G.R. de, Jong, F.W.M. de, 1999. Bestrijdingsmiddelen en milieu. Uitgeverij Jan van Arkel, Utrecht.

Snoo, G.R. de, Ven, G.W.J. van de, 1999. Environmental themes on ecolabels. Landscape and urban planning 46, 179-184.

Snoo, G.R. de, Wit, P.J. de, 1995. Unsprayed crop edges for reducing pesticide drift from field sprayers to ditches and ditch banks. Ecotoxicity and Environmental Safety 41, 112-118.

Stichting Milieukeur, 1996. Jaarverslag 1995. Stichting Milieukeur, Den Haag.

Stichting Milieukeur, 1998a. Certificatieschema voor de teelt van aardappelen. Stichting Milieukeur, Den Haag.

Stichting Milieukeur, 1998b. Certificatieschema voor de teelt van vollegrondsgroenten. Stichting Milieukeur, Den Haag.

Stichting Milieukeur, 2000. Concept Certificatieschema Milieukeur akkerbouw. Stichting Milieukeur, Den Haag

STOWA, 1998. Ecologisch onderzoek naar de effecten van bufferstroken langs watergangen, een literatuuronderzoek naar werking, rendement en kansrijkdom. STOWA 98-16, Utrecht.

Swedish FSC Working group secretariat, 1997. Swedish FSC Standards for Forest Certification. Source: www.fsc-sweden.org/gron/stand.html

Udo de Haes, H.A., Jolliet, O., Finnveden, G., Hauschild, M., Krewitt, W., Müller-Wenk, R., 1999. Best available practice regarding impact categories and category indicators in life cycle impact assessment. Background document for the Second Working Group on Life Cycle Impact Assessment of SETAC-Europe (WIA-2). International Journal of Life Cycle Assessment 4 (2).

Vries, G.J.H. de, Middelkoop, N., Weijden, W.J. van der, 1997. Milieuprestaties van EKO-landbouw. Centre for Agriculture and Environment (CLM), Utrecht.

Vries, G.J.H. de, Middelkoop, N., Pak, G.A., 1998. De ecologische duurzaamheid van land- en tuinbouw. Vergelijking van 'biologisch' en 'Milieukeur'. Centre for Agriculture and Environment (CLM), Utrecht.

VROM (Dutch Ministry of Housing, Spatial Planning and Environment), 1995. Integrale Notitie Mest- en Ammoniakbeleid. VROM, Den Haag.

V&W (Dutch Ministry of Transport, Public Works and Water Management), LNV (Dutch Ministry of Agriculture, Nature Management and Fisheries), VROM (Dutch Ministry of Housing, Spatial Planning and Environment) and Unie van Waterschappen (Union of District Water Boards), 1997. Water kader. Vierde nota waterhuishouding. Regeringsvoornemen. Den Haag.

V&W (Dutch Ministry of Transport, Public Works and Water Management), VROM (Dutch Ministry of Housing, Spatial Planning and Environment) and LNV (Dutch Ministry of Agriculture, Nature Management and Fisheries), 2000. Lozingenbesluit Open teelten en veehouderij. Den Haag.

Weijden, W.J. van der, Wal, H. van der, Graaf, H.J. de, Brussel, N.A. van, Keurs, W.J. ter, 1984. Bouwstenen voor een geïntegreerde landbouw. WRR (Netherlands Scientific Council for Government Policy), Den Haag

Zande, J.C. van de, Holterman, H.J., Huisman, J.F.M., 1995. Driftbeperking bij de toediening van gewasbeschermingsmiddelen. Evaluatie van de technische mogelijkheden met een driftmodel. Report 95-15, IMAG-DLO, Wageningen.