Ministry for Environment, Land and Sea

Ministry for Agriculture, Food and Forestry Policies

Regions of Piedmont, Lombardy, Veneto, Emilia-Romagna and Friuli Venezia Giulia

Request from Italy for a derogation under paragraph 2(b) of Annex III to Directive 91/676/EEC from the limit of 170 kilograms of Nitrogen per hectare per year from livestock manure

January 2010

This paper has been prepared by a working group including members of the Ministry for Environment, Land and See, Ministry of Agriculture, Food and Forestry Policies, regions of Piedmont, Lombardy, Veneto, Emilia-Romagna and Friuli Venezia Giulia, SIN srl Area Ingegneria, with the scientific support of Centro Ricerche Produzioni Animali – CRPA S.p.A. (Research Centre on Animal Production, Reggio Emilia), ERSAF Lombardy and Universities of Turin, Milan and Padua.

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Introduction

This paper provides an outline of the intended request for derogation from Italy.

The derogation request refers to the regions of Northern Italy: Piedmont, Lombardy, Emilia-Romagna, Veneto and Friuli Venezia Giulia (*Figure 1*). Therefore, this paper is mainly focused on these regions.

These regions account for 68% of dairy cattle, 61% of other cattle, 85% of pigs and 80% of poultry of the total livestock reared in Italy.

In Northern Italy, due to favourable soil and climatic conditions and water availability, yield potential and crop nutrient uptake are very high. A large proportion of the plain (clay and medium soils) is characterised by low vulnerability of aquifers due to the geological and pedological conditions which determine a low permeability of soil and subsoil.

Derogation is aimed at allowing farmers to use a higher proportion of nitrogen from livestock manure in their fertilisation practices, while not significantly increasing total nitrogen (N) application and limiting phosphorus (P) application, taking into account crop uptake and soil characteristics. This is achieved by requiring derogation farms to comply with specific conditions, for instance reaching higher manure N efficiency and establishing treatment requirements for certain manure types.

Stricter control on agricultural practices and specific programs of water monitoring in agricultural catchments will guarantee that derogation will not prejudice the achievement of the nitrates directive objectives as well as the compliance with the other relevant EU legislation.

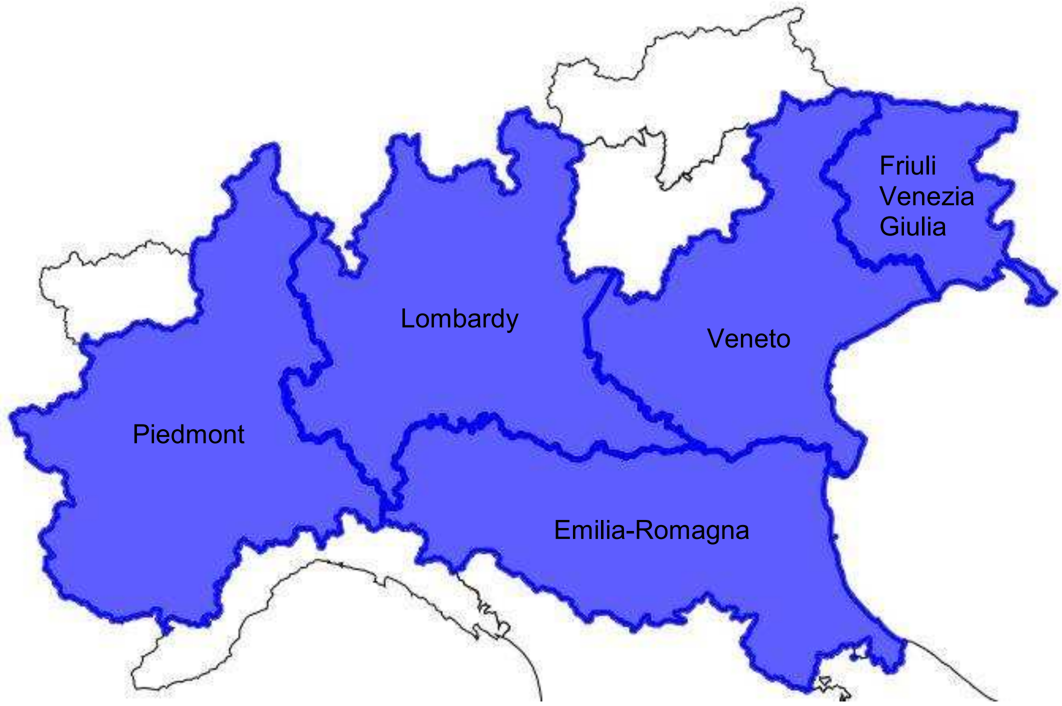


Figure 1 – Italian territory encompassed by the derogation request

1. Water quality

The report on implementation of the Nitrates Directive in Italy for the period 2004-2007 shows that nitrate monitoring network substantially increased.

1.1 Groundwater

Concerning groundwater, national data (*Figure 2*) show that a large majority of monitoring stations (88 %) have a mean nitrate concentration of less than 50 mg/l nitrate and 2/3 (66%) recorded mean nitrate concentrations below 25 mg/l nitrate.

In the regions of Northern Italy, the proportion of monitoring station showing mean nitrate concentration below 50 mg/l and below 25 mg/l nitrates are in the same range and correspond respectively to 89% and to 63%. Monitoring stations where mean nitrate concentration exceeded 50 mg/l nitrate represented 11 % of the total of sampling sites (*Figure 3*).

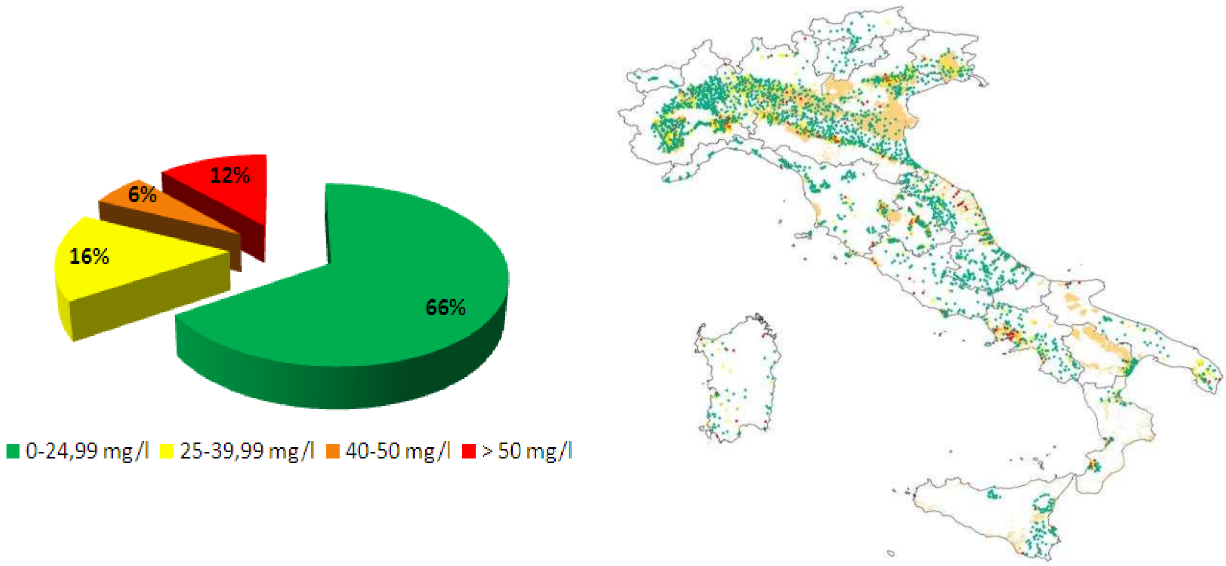


Figure 2 – Nitrate concentrations in groundwater in Italy (period 2004-2007).

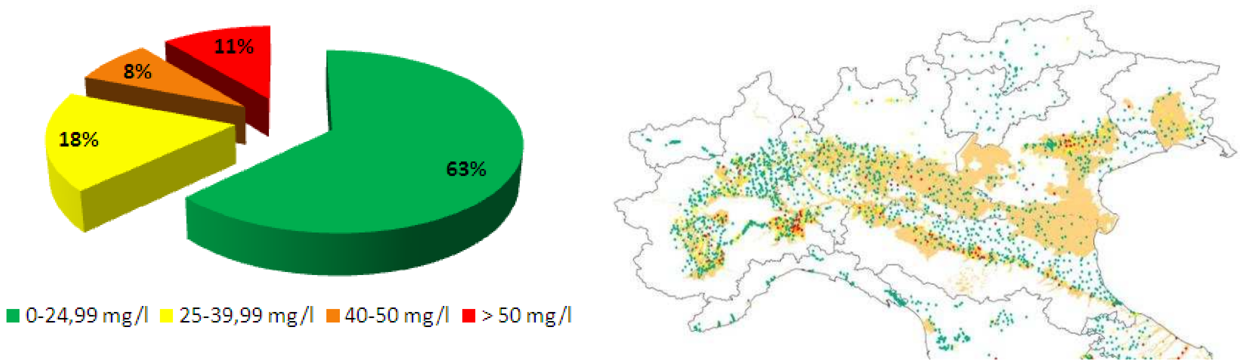


Figure 3 – Nitrate concentrations in groundwater in the regions of Northern Italy (period 2004-2007).

Groundwater with a mean nitrate concentration above 25 mg/litre is mainly located at the foothills of the Alps and of the Apennines, characterised by highly permeable soils, which are now designated as Nitrates Vulnerable Zones. *Figure* 4 shows the trends of nitrate concentrations in groundwater in the regions of Northern Italy between the periods 2000-2003 and 2004-2007. Even if in large majority of sampling points nitrate concentration is stable or decreasing (57%) from these data it appears that intensification of agriculture in the past years is still contributing to a trend of rising nitrate concentrations in aquifers notwithstanding measures taken, due to the long response times. Groundwater, in fact, especially in some aquifer types, responds very slowly to changes in agricultural practices.

A long time span is needed, in these cases, in order to detect consolidated signs of trend reversal, which are expected as a consequence of the implementation of the action programmes. Anyway, overall data from individual regions, as presented in *Figure 5*, from year 2008, show an encouraging decreasing trend in nitrate concentration.

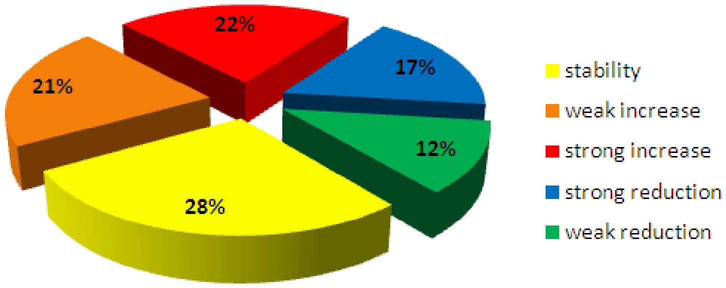
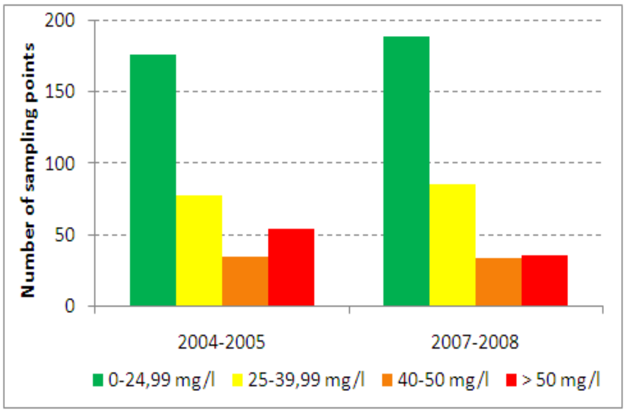


Figure 4 - Trends in nitrates in groundwater in the regions of Northern Italy between the periods 2000-2003 and 2004-2007

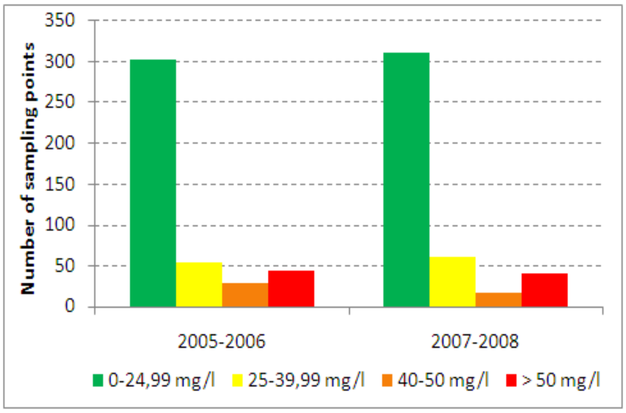
PIEDMONT

mg/l NO_3	2004-2005	2007-2008
0-24,99 mg/l	177	189
25-39,99 mg/l	78	86
40-50 mg/l	35	34
> 50 mg/l	55	36
Total sampling points	345	345



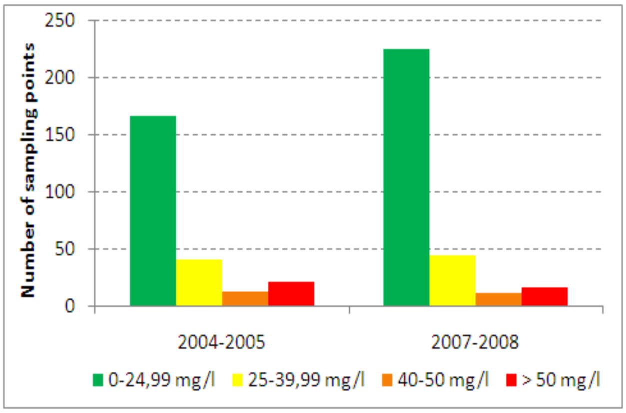
EMILIA-ROMAGNA

mg/l NO_3	2005-2006	2007-2008
0-24,99 mg/l	303	311
25-39,99 mg/l	54	61
40-50 mg/l	28	17
> 50 mg/l	44	41
Total sampling points	429	430



VENETO

mg/l NO_3	2004-2005	2007-2008
0-24,99 mg/l	167	225
25-39,99 mg/l	42	45
40-50 mg/l	13	12
> 50 mg/l	22	17
Total sampling points	244	299



LOMBARDY

mg/l NO_3	2002-2008	2002-2005	2006-2008
Region	17,66	18,25	17,38
NVZ	21,11	21,44	20,95
Non NVZ	13,71	14,61	13,3

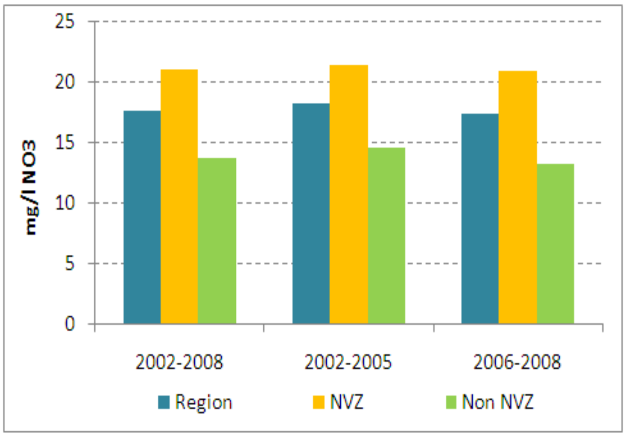


Figure 5 - Regional updates on average nitrate concentration in groundwater

1.2 Surface waters

Figure 6 and *Figure 7* show the percentage of monitoring points in each quality class of mean nitrate concentration in surface waters in 2006-2007 respectively in Italy and in the Regions of Northern Italy. In Italy approximately 98% of monitoring points have a mean concentration of less than 25 mg/l nitrate; the proportion is in the same range in the regions of Northern Italy. Higher nitrate concentrations are recorded in the rivers flowing from the Apennines due to the relatively low flow, in particular in summer period and in the rivers of Veneto region, especially those originated from the recharge area significantly polluted with nitrates.

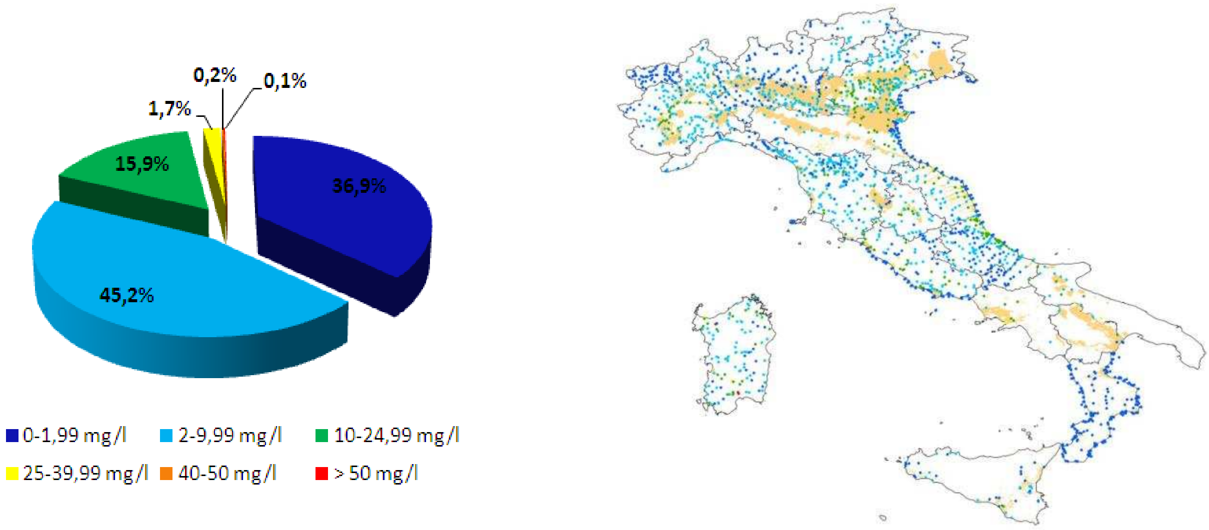


Figure 6 - Nitrate concentrations in surface waters in Italy (period 2004-2007).

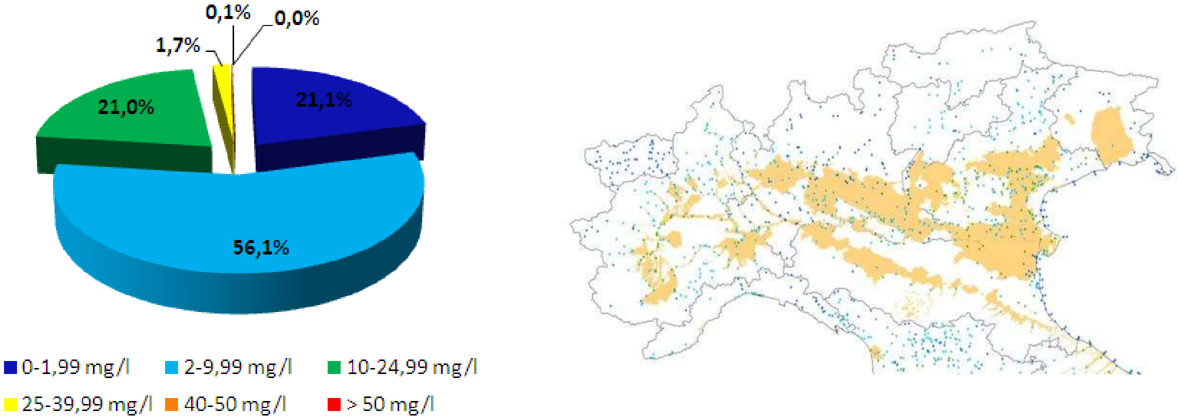


Figure 7 – Nitrate concentrations in surface waters in the regions of Northern Italy (period 2004-2007).

Since the previous period, even if inter-annual fluctuations in river flows due to climatic conditions might have had significant effect, monitoring data show a trend towards gradual reduction in nitrate (with 75% of points stable or decreasing nitrate concentration) and phosphate concentration in surface water, partly due to a better efficiency of urban wastewater treatment plants, but also due to a trend towards better farm and nutrient management practices, reduced livestock numbers and reduced use of chemical fertilisers.

With specific reference to nutrient loading to the Adriatic Sea, which is monitored at the river mouth and is based on detailed measurements, including during flood events, data confirm the trend towards reduction of total N and P loadings in the period 1999-2000, even if with the variability due to hydrologic regime (*Figure 8*).

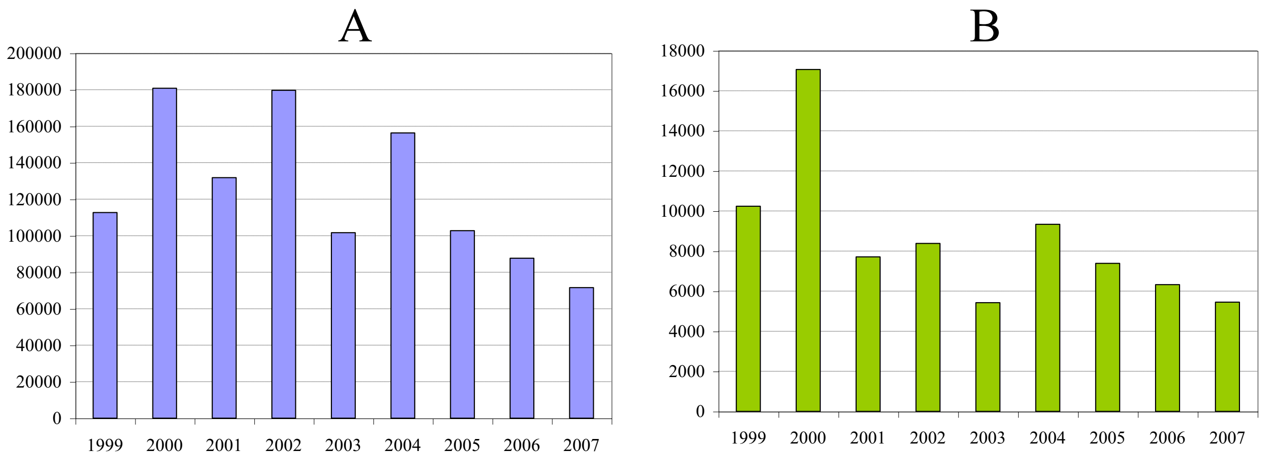


Figure 8 – Total nitrogen (A) and phosphorus (B) loadings from the Po river to the Adriatic Sea (data are expressed in tons per year. Source: Po River basin Authority, 2008)

1.3 Phosphorus in surface water

Actions in the field of urban wastewater treatment, improvement of livestock feeding practices and fertilisation, through advisory services (see also paragraph 2.6.3), contributed to the reduction of emission and P loading to water over the years, as illustrated, for instance, with reference to the P loading from the Po river to the Adriatic Sea, in *Figure 8* above.

Moreover, in order to address eutrophication, Italy took a regulatory approach, since 1985, to limit P in detergents. National regulation established maximum P concentration in the different types of detergents to reduce wastewater pollution at the source.

The regional water monitoring programmes assess Phosphorus concentration in waters on a regular basis. *Figure 9* and *Figure 10* show average concentrations of Total Phosphorus and Ortophosfate in the regions of Northern Italy and the percentage of sampling points belonging to each quality class (for both total P and PO_4) in the period 2007-2008. 66% of monitoring points have a total P concentration below 0,15 mg/L and 82% of monitoring points have an orthophosphate concentration below 0,5 mg PO_4/litre.

Concerning trends (*Table 1*), 74% of common monitoring points are either stable or showed a decrease since 2004-2005.

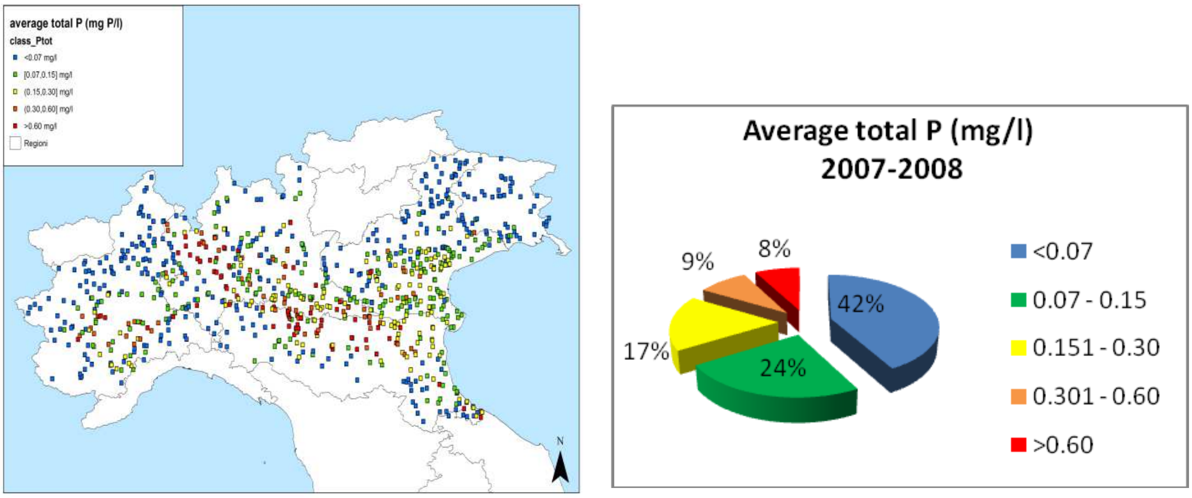


Figure 9 – Average total P concentration in surface water monitoring points (2007-2008)

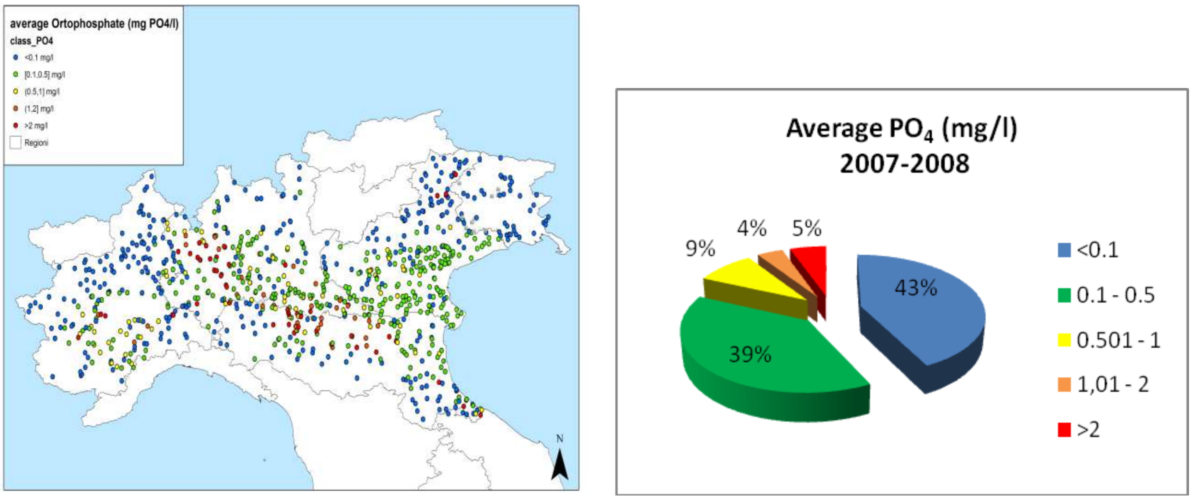


Figure 10 – Average orthophosphate concentration in surface water monitoring points (2007-2008)

<-0.25 Strong decrease	-0.25 to -0.05 Weak decrease	-0.05 to +0.05 Stable	+0.05 to +0.25 Weak increase	>+0.25 Strong increase
5	13	56	17	9

Table 1 – Variation in surface water orthophosphate concentration (mg PO_4/litre) in the regions of Northern Italy based on average values between 2004-2005 and 2007-2008 periods (% of common monitoring points).

1.4 Action to control nutrient pollution of water from agricultural sources

The control of pollution from diffuse sources in Italy takes place through legislative initiatives, advisory services and promotion of voluntary measures aimed at supporting good farming practices.

Governments have also developed necessary legislation including implementation of the requirements of EC Directives into national legislation and the effective enforcement by the competent authorities.

1.4.1 Implementation of the Nitrates Directive

Implementation of the Nitrates Directive in Italy lies in the competence of the Regional Authorities. However, in order to establish a common ground for implementation, the Ministerial Decree of 7 April 2006 sets out provisions at national level, establishing, for instance, criteria for storage design and volumes, minimum length of closed periods, minimum width of buffer strips along water courses, procedures for establishing nitrogen application, manure N excretion standard coefficients, fertilisation planning and the limit of 170 kg N per hectare per year from manure in nitrate vulnerable zones. It is highlighted that this decree regulates management of fertilisers in nitrates vulnerable zones and manure management on the whole Italian territory establishing minimum requirements such as on manure storage, closed periods and band strips along the water courses. Regional regulations concerning manure management have been in force since 1995 in Northern Italy and have been progressively tightened. Recently (between 2006 and 2008 depending on the region), they were integrated incorporating the detailed provisions of the national decree, and establishing specific action programmes at regional level in order to tailor the requirements of the national framework to the very diverse climatic, land use and agronomic conditions of the Italian territory (see **Annex I** for the reference to the regional Acts implementing the Action Programmes).

In the same period in the regions applying for derogation (Piedmont/Lombardy/Emilia-Romagna/Veneto/Friuli Venezia Giulia) the Nitrate Vulnerable Zones have been enlarged with new designations (see next paragraph).

The measures of the action programmes apply within designated nitrate vulnerable areas that cover 67% of the agricultural area of Northern Italy.

The key measures in the Action Programmes in the regions of Northern Italy are outlined below.

- A limit of 170 kg per ha per year of livestock manure N.
- A minimum storage capacity requirement of 6 months for pig slurry, poultry and cattle manure, with the exception of dairy cattle manure in case of farms with a rotation including grassland, for which a minimum of 4 month storage is required in NVZ. Appropriate construction standards for storage vessels are established.
- Minimum storage capacity of 90 days of solid manure on a tight platform and controls on the temporary storage of solid manure in field heaps.
- A requirement to plan the applications of all nitrogen fertilisers, including thorough compulsory fertilisation plans to be notified to the competent authorities before spreading. The procedure for preparation of the fertilisation plans is established in the national framework action programme .
- A limit on the rate of nitrogen fertilisers that may be applied to individual crops, based on N crop uptake (N concentration in crops multiplied by crop yield) and, in any case, not exceeding the mandatory limits established in the code of GAP. The contribution of crop available manure N to the limit depends on soil type and must be calculated using the following mandatory values for the manure N efficiency (% of total N applied).

- cattle slurry 41%
- pig slurry 48%
- poultry manure 55%

- In case of liquid manure the decree envisages that higher efficiency factors have to be achieved by 2011 (cattle slurry: 50%; pig slurry and poultry manure: 60%). Concerning non-derogation farms, at present, a further increase of efficiency factors is not foreseen, but the whole issue will be reconsidered in due time, within the process of the four year cycle of review and possible revision of action programmes required by the nitrates directive
- Closed periods for manure spreading: from 1st November to 28 February on all soil types for slurry and from 1st November or 1st December to 31 January or 28 February for solid manure, depending on the region. A closed period is also established for spreading of chemical nitrogen fertiliser.
- Minimum width of 5 to 10 m along water course for spreading of solid manure, chemical fertilisers and slurry.

According to the requirements of nitrate directive, the national framework action programme and the regional action programmes in the five regions of Northern Italy applying for derogation will be reviewed and, if needed, revised within 4 years from entering into force. In particular, it is foreseen that the review process will be carried out in parallel with the discussion on derogation and, in principle, the reviewed national framework programme and the regional action programmes will enter into force at the same time as the derogation (by 30 June 2010 or 1 January 2011 at the latest).

The revised Action Programmes of the five regions applying for derogation, in case derogation request were approved, will contain five main additional measures:

- ♦ the Autumn distribution of manure will be gradually reduced, in order to achieve a higher Nitrogen Use Efficiency (NUE);
- ♦ derogation farms are required to improve manure management increasing the NUE up to at least 65% when applying animal manure: this is one of the stricter mandatory measures to be applied in order to balance the environmental effects of application of a higher amount of organic nitrogen;
- ♦ if solid/liquid separation is applied for spreading of the liquid fraction at rates exceeding 170 kg N/ha·year, export of solid fraction from the derogation farm is a mandatory measure;
- ♦ mineral Phosphorus application is not permitted in derogation farms;
- ♦ phosphorus application with manure in the derogation farm shall correspond to crop need calculated on the basis of the crop rotation or exceed crop need by no more than 15%.

Code of Good Agricultural Practice (CoGAP)

The Nitrates Directive Annex II requires that a Code of Good Agricultural Practice shall be established and promoted to farmers with the objective of reducing pollution by nitrates.

The Code was established in 1999 with the ministerial Decree 19 April 1999 “Approval of Code of good agricultural practices”. The Code provides advice on best practices for preventing environmental pollution from farming activities and is actively promoted by advisory services.

1.4.2 Other Government and regional initiatives

This paragraph provides an overview of the measures, funded through RDPs, which may help implementation of Nitrates Directive and Water Framework Directive. The five regions encompassed by the derogation have also submitted by 15 July 2009 their proposals for modulation funds 2010-2013 which are now under scrutiny by the European Commission.

Measures under RDPs which have been identified as being directly or indirectly supporting implementation of the nitrates directive are agri-environmental measures and measures supporting renewable energy production through manure treatment (improving manure quality, facilitating management and increasing N efficiency):

- Measure 214 - "Agri-environment payments". Some measures are particularly relevant for nitrates directive implementation: organic farming, integrated farming, soil management and conservation/enhancement of organic matter, conversion of arable land into grassland and conservation and enhancement of buffer strips.
- Measure. 121 - "Modernisation of agricultural holdings, improving the overall performance of the agricultural holdings". In the framework of measure 121 renewable energy production (for instance anaerobic digestion plants treating livestock manure and covered storages with collection and utilisation of biogas) and investments for water protection and improvement of environment are eligible.
- Measure 131 – "Improvement of environmental performances in livestock production to meet European recent mandatory regulations". This measure supports additional costs following the introduction of regulations concernings water pollution by nitrates (D.M. 7 April 2006). Through this measure, for instance, about 2,300 farms have been financed in NVZs of Veneto region.
- Measure 311 – "Diversification in non agricultural activities"
- Measure 312 – "Development of new enterprise"

These latter measures can also be applicable to support renewable energy production including from livestock manure in specific conditions.

In addition to the above, regions are applying measures concerning water protection at catchment level.

For instance, in NVZs of Veneto, where the primary land use is cereals (maize and wheat) fertilised with manure of intensive livestock production, two innovative techniques of water bodies protection have been designed and already established:

A) multi-species riparian buffer strips have been placed along streams for a total of 3000 km, preventing soil erosion, soil degradation and nutrient losses (N, P);

B) constructed wetlands, connected with a controlled artificial drainage system, have been realised to promote denitrification and to act as "lamination" areas providing protection from river flooding.

The objective of the regions is to extend the protection areas in the frame of the Basin Management Plans as foreseen by WFD.

Funding by axis

The total budget for implementation of rural development programme from EFSRD budget and from national funding in Italy is 16.604 million Euro (8.292 from EFSRD budget). Resources are allocated mainly on Axis 1 (6.400 million Euro) and on Axis 2 (approximately 7.000 million Euro).

The table below shows allocation of funds for the measures previously mentioned, with 22,2 % of the budget for RDPs allocated to agri-environmental measures.

Measure	**Total budget**	
	% RDPs	*%Axis*
Axis 1	**38,7%**	
measure 112	4,8%	12,4%
measure 121	14,1%	36,5%
measure 131	0,3%	0,8%
Axis 2	**42,0%**	
measure 214	22,4%	53,2%
measure 216	1,4%	3,4%
Axis 3	**8,5%**	
measure 311	3,5%	40,7%
measure a 312	0,5%	6,4%

Table 2 - Budget of some RDP measures (% per axis and per measures), Italy (all regions).

Structural funds

The National Strategic Framework 2007/2013 identifies, among the other priorities “Energy and environment”, including energy production from renewable sources and energy saving, also in the light of the required reduction of greenhouse gas emission to comply with objectives set out in the Kyoto protocol. This is reflected in the regional operational plans.

The National Strategic Framework includes an "Interregional Operational plan” "Renewable energy and energy saving” " for the convergence regions. The general objective of the programme is increasing the proportion of energy from renewable sources and promoting opportunities for local development. The programme has a total budget of 1600 million Euro and will support integrated projects of energy production from renewable sources and energy saving and also projects aimed at reducing and recovering N in manure.

1.5 Nitrate Vulnerable Zones

The designation of Nitrates vulnerable zones in Italy falls under the competence of the Regions. Designation, which took place in the late nineties, has been enlarged between 2006 and 2008. Designation is based on the criteria set out in article 3 and Annex 1 of nitrates directive, on the basis of the results of monitoring programmes assessing nitrate concentration in surface and groundwaters and trophic status of surface waters.

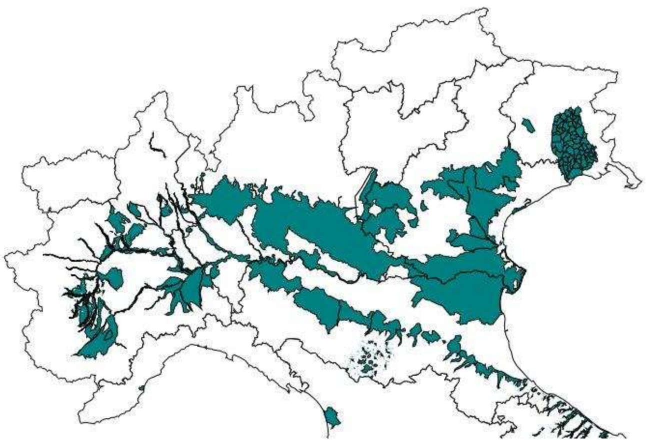


Figure 11 - Designated Nitrate Vulnerable Zones (NVZ) in Italy

In the 5 regions encompassed by the derogation request, designated NVZ correspond to 2,778,697 ha, which represent almost 70% of designated NVZs in Italy. NVZs represent approximately 67% of the utilised agricultural area (UAA) in Northern Italy. In detail the percentage of NVZs over the UAA exceeds 80% in Lombardy, Friuli Venezia Giulia and Veneto; in Emilia-Romagna it corresponds approximately to 60% and in Piedmont to about 40% (see *Table 3*).

According to the requirements of Nitrates Directive designation will be reviewed by the regions within four years. At this stage, on the basis of available data and information, it is not foreseen to modify the current designation, which will, therefore, be confirmed for the next four year cycle and will be the basis of the next action programmes and derogation.

Region	**NVZ area (ha)**	**% NVZ/TLA**	**% NVZ/UAA**	**%NVZ/RPA**
Piedmont	402,377	15.4	37.6	54
Lombardy	814,176	34.1	81.8	56
Veneto	717,800	39.0	87.5	60
Emilia-Romagna	661,200	29.9	62.8	57
Friuli Venezia Giulia	183,144	23.3	80.3	53

Table 3 – Nitrates Vulnerable Zones per regions applying for derogation with percentage on total land area (TLA), on utilised agricultural area (UAA), on regional plain areas (RPA)

2. Overview of agriculture, climate and soil

2.1 Cropping systems

The main cropping systems in Northern Italy are cereals and forages, generally with high yields and N uptake (*Table 4* and *Figure 12-Figure 15*).

	Maize grain	Maize silage	Winter cereals	Permanent grasslands	Temporary grasslands	Lucerne	Others
Piedmont	189,073	18,329	134,104	93,091	21,362	19,570	425,753
Lombardy	253,741	111,490	133,280	136,220	20,326	57,707	284,446
Veneto	237,797	45,893	132,941	85,594	6,327	18,318	286,463
Friuli Venezia G.	85,320	4,400	26,582	14,875		10,960	98,998
Emilia-Romagna	111,255	18,920	287,627	61,770	5,000	272,900	412,335
Total 5 regions	**877,186**	**199,032**	**714,534**	**391,550**	**53,015**	**379,455**	**1,507,995**
%	*21*	*5*	*17*	*9*	*1*	*9*	*37*

Table 4 - Main crops in the regions of Northern Italy (ha), 2008 (CRPA elaboration from ISTAT data).

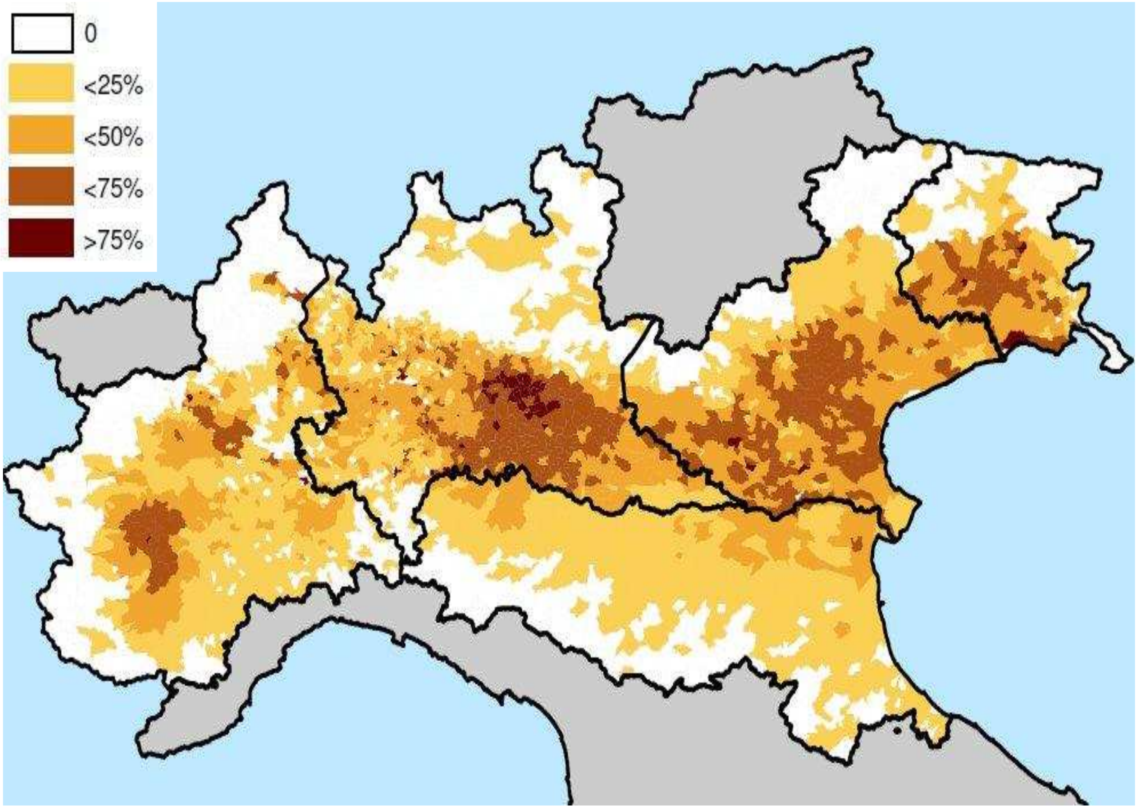


Figure 12 – Geographical distribution of maize crop, expressed as a percentage on total agricultural area for each municipality (SIN elaboration from RRN data, with reference to UAA declared by farms on "Domanda Unica 2007").

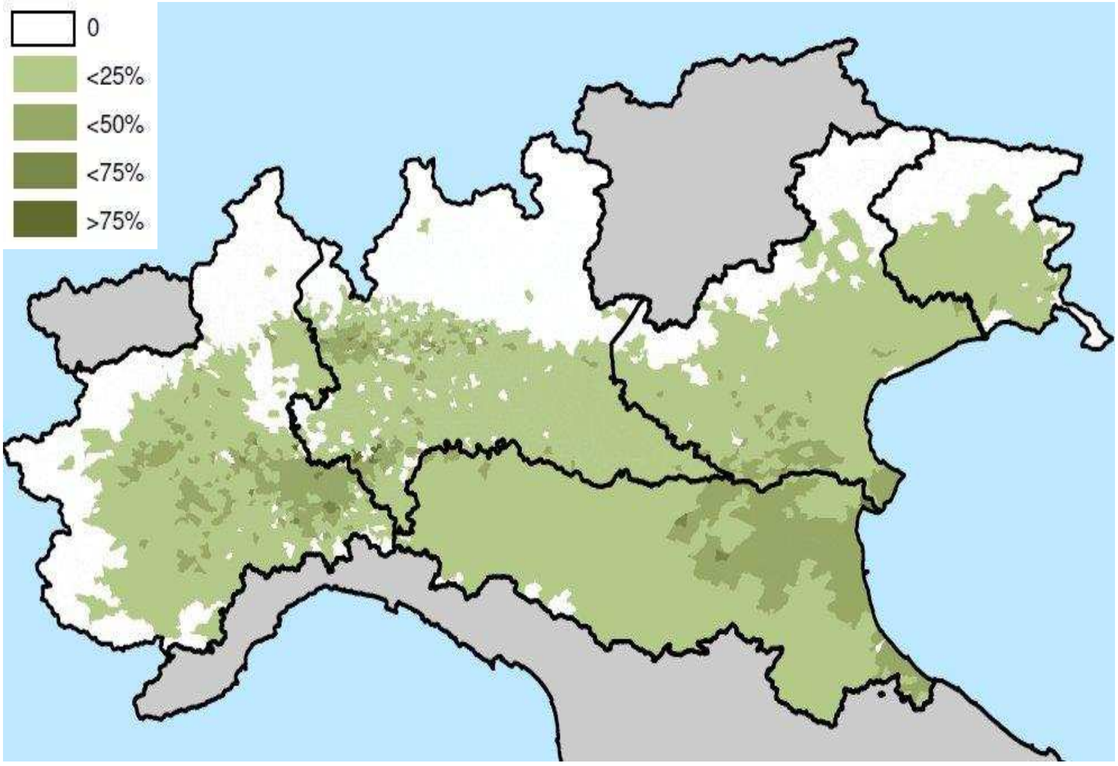


Figure 13 – Geographical distribution of winter cereals crop, expressed as a percentage on total agricultural area for each municipality (SIN elaboration from RRN data, with reference to UAA declared by farms on "Domanda Unica 2007").

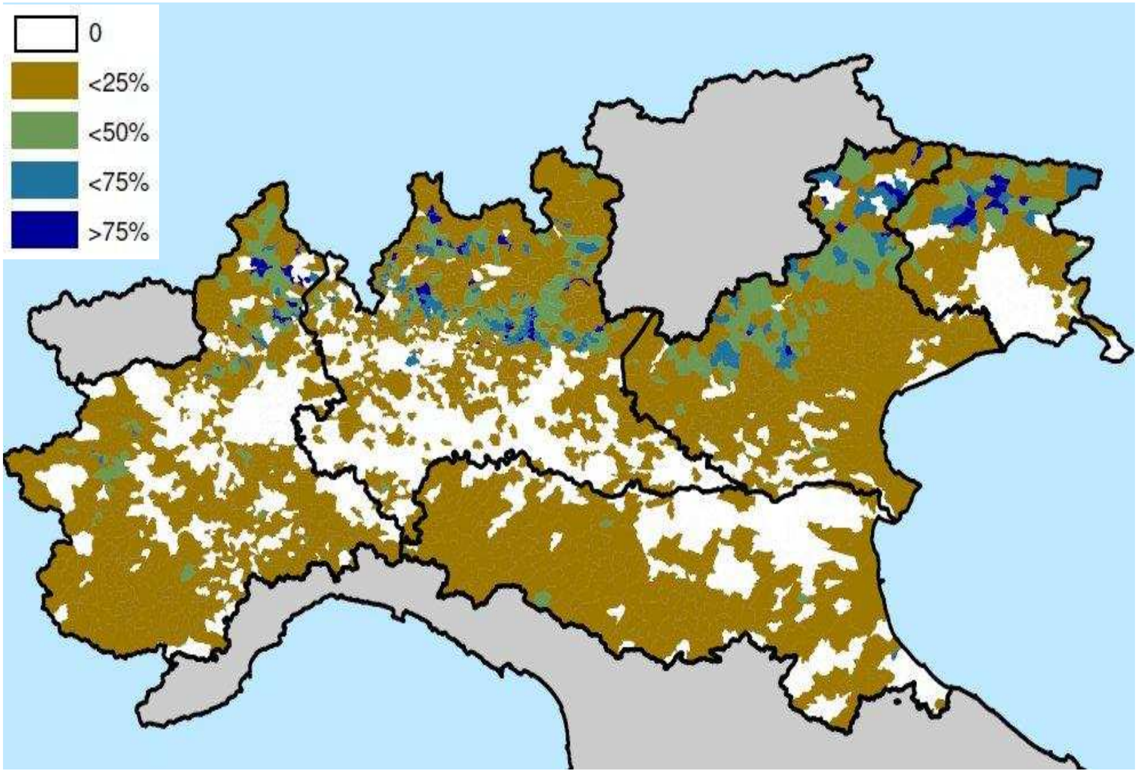


Figure 14 – Geographical distribution of permanent grasslands crop, expressed as a percentage on total agricultural area for each municipality (SIN elaboration from RRN data, with reference to UAA declared by farms on "Domanda Unica 2007").

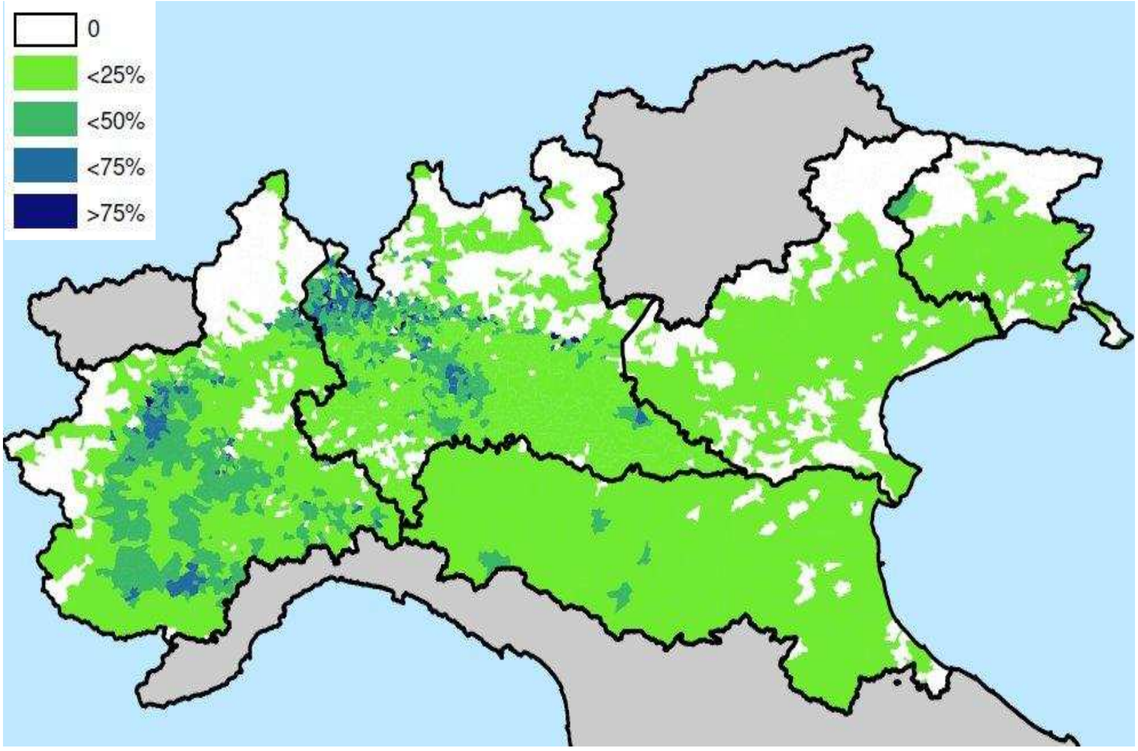


Figure 15 – Geographical distribution of temporary grasslands crop, expressed as a percentage on total agricultural area for each municipality (SIN elaboration from RRN data, with reference to UAA declared by farms on "Domanda Unica 2007").

Farming systems in the plains of the Northern Italy are strictly linked to livestock type: i) Dairy cattle, ii) Beef cattle and iii) Pig.

The dairy farms show peculiar characteristics when milk production is aimed at producing Parmigiano-Reggiano cheese (mainly in Emilia-Romagna provinces of Reggio Emilia and Parma). In this latter case, use of silage for feeding is forbidden.

The beef system is specialised in fattening young calves imported from abroad, mainly France or European Eastern countries. A particular type of the beef cattle farming takes place in Piedmont, based on a local breed (Piemontese breed). These farms grow their own calves (this group will be referred to as "suckling cows").

Table 5 shows the share of the main crops cultivated in the different farming systems.

Crop	**Dairy cattle**	**Beef cattle**	**Suckling cows**	**Pigs**
Maize (%)	25-47	45-72	32-38	48-69
Grassland (%)	22-36	8-9	39-48	0-3
Winter cereals (%)	16-30	18-31	11-22	19-27
Other crops (%)	8-14	2-15	1-9	1-16

Table 5 - Main cropping systems of the different farm types (data from University of Turin, modified by CRPA).

Maize (*Zea mays* L.) is the main crop, in particular in beef and pig systems, with more than 50% of the farm area. This cereal is used for grains or for silage. In case of pig farms and dairy farms in the area of Parmigiano-Reggiano maize is mainly cropped for grain. Maize silage is banned in this area, to prevent clostridium presence in milk which would damage this particular cheese (no additive is used in this production). In other dairy farms, silage maize ranges from a half to the entire surface. In the suckling cow farms silage maize represents often one third of the entire maize area.

Maize can be grown as a monoculture in pig farms and is often in rotation with winter cereals, leys or other herbages in the other farm types. In some area of the Po Valley plain, where soil is suitable and other conditions are favourable, dairy farms develop a typical cropping system with two crops per year: maize for silage (early-medium maturing hybrids) in combination with winter Italian ryegrass (*Lolium multiflorum* Lam.) or silage barley (*Hordeum vulgare* L.).

Maize in livestock farms is irrigated, because historically livestock farming developed in area rich of water. Availability of water for irrigation increases maize yield and the length of the growing season.

Where maize is not a profitable crop and in case silage maize in dairy cattle diet is not allowed (Parmigiano-Reggiano area), for rotational purposes, permanent or rotational grassland is cultivated. Grassland is cut four to five times per year for silage and/or hay production. Animal grazing is always an exception in Northern Italy (apart from the territories in the Alps). The two main types of rotation grassland are: i) mixture of grasses (*Lolium multiflorum*, *Festuca arundinacea*) and legumes (*Trifolium repens* or *T. pratense*) and ii) pure lucerne ley *(Medicago sativa)*. Lucerne often does not require irrigation and in some areas, characterised by clay soils, represents an important fodder crop in dairy farms.

The share of grassland area is very variable among farm types and agro-environments. Dairy farms, in particular in Parmigiano-Reggiano area, have a larger share of grassland. Winter cereals are mainly winter wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.). Winter cereals are more frequent in short rotations, where irrigation water is less available and straw for bedding is needed. In livestock farms wheat is always sold as a cash crop. Barley can either be sold or used as fodder crop (both grain and silage barley).

2.2 Irrigation and drainage

The Po river basin is very rich of water, which is used for various purposes, including irrigation. A complex network of channels dating back, in some cases, to the XIIth century allows water transfer for irrigation from the Po river and its affluents at the foothills of the Alps, downstream the large Alpine lakes, downwards, to the very productive plains of the Po river basin. The network of natural and artificial water bodies is very dense and was implemented along the centuries (see *Figure 16*).

A network of small channels distributes water for irrigation to agricultural land, also very far from the derivation points. 75% of the Po river plains is served by the irrigation network and 36 irrigation Consortia of irrigation and drainage have been set up.

In parallel with the irrigation system, the Po river basin is served by a complex drainage system, partly based on natural drainage and partly requiring artificial drainage through pumping.

Water utilisation from surface water for agriculture is estimated in approximately 17 $*10^9$ m^3/year. Water flowing through the irrigation network to a quite large agricultural area supports agricultural production, but also contributes to groundwater recharges and to habitat conservation.

The estimated average efficiency of transport and distribution of the network is approximately 69%, while the overall efficiency is much lower (approximately 20-40%).

Irrigation methods are different in the different agricultural area. In Piedmont and Lombardy surface irrigation or furrow irrigation are the prevailing techniques. Elsewhere sprinkler irrigation is used. The number of irrigations varies greatly in different environments and years. Three or four irrigation events can be seen as representative of a frequent technique. The less available is the water the more frequent is sprinkler irrigation instead of surface irrigation. Low water consumption irrigation systems are widespread in Emilia-Romagna, due to summer droughts and lesser water availability for irrigation (sprinkler irrigation, drip lines).

Modernisation of the irrigation systems in order to achieve a better efficiency of water use is a key objective, also through a National Strategic Irrigation Plan and specific measures in the RDPs.

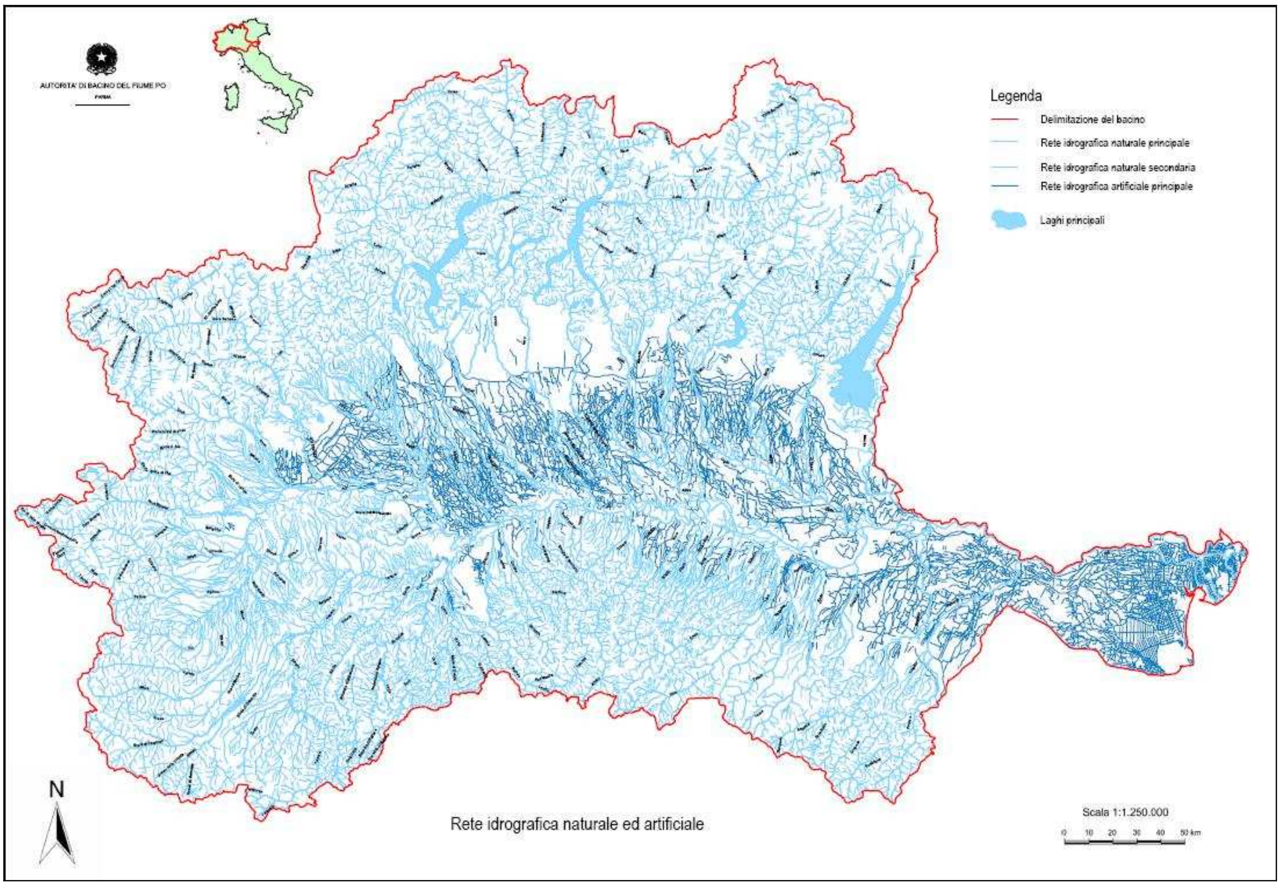


Figure 16 - Natural and artificial network in the Po river basin.

2.3 Livestock farming systems in the five regions

2.3.1 Trends, average size of livestock farms

The five regions of Northern Italy account for more than 70% of livestock in Italy: in particular, 68% dairy cattle, 61% other cattle, 85% pigs and 80% poultry (data 2007).

In general livestock farming in these regions, as in the whole Italy, is facing a long time crisis due to several factors, for instance:

a) competition due to globalisation and open markets;

b) increasing production costs due to feedstuff increasing costs, and costs due to farm infrastructure improvements to comply with environmental and animal welfare regulations;

c) crisis such as BSE, Blue Tongue and avian flue;

d) declining of market prices of the products of animal origin;

e) abandonment of the livestock farming activities.

The consequences were a decline of the livestock number since the early eighties, till the recent years when the number of Livestock Units (LU) substantially stabilised (*Figure 17*).

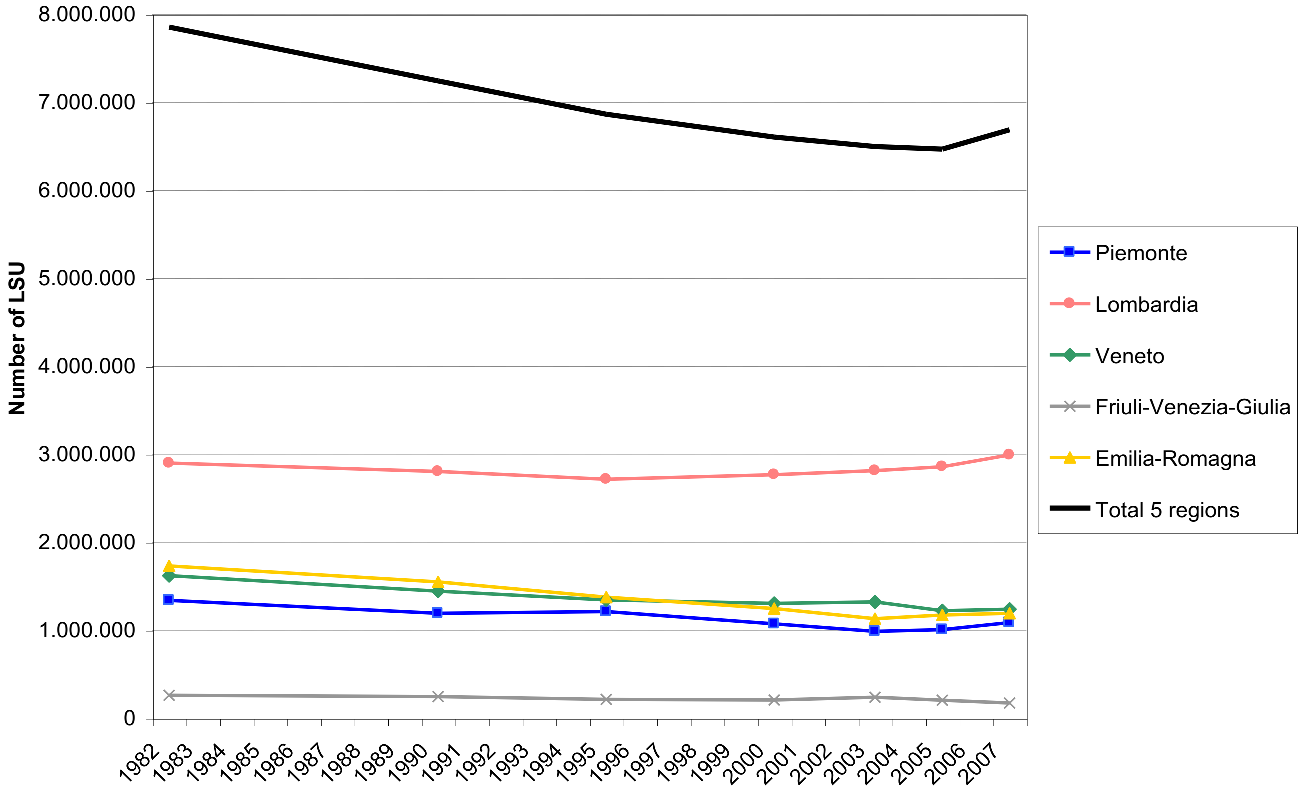


Figure 17 – Trends in livestock farming in the 5 regions of Northern Italy from 1982 to 2007, livestock units - LU (cattle, pig and poultry) (CRPA, based on ISTAT).

Cattle sector accounts for most of the decline.

	Dairy cows	Other cows	Pigs	Broilers	Laying hens	Total
Piedmont	7,281	16,242	2,429	1,390	1,788	29,130
Lombardy	8,728	6,854	4,341	1,466	2,533	23,922
Veneto	6,091	10,199	3,634	1,140	2,963	24,027
Friuli Venezia G.	1,174	390	1,477	108	231	3,380
Emilia-Romagna	5,133	3,402	1,541	558	406	11,040
Total 5 regions	28,407	37,087	13,422	4,662	7,921	91,499

Table 6 - Number of livestock farms per region, 2007 (CRPA elaboration from ISTAT data).

In the five regions of Northern Italy the average farm size is larger than the national average, but the proportion of small farms is still relevant.

In the 5 regions applying for derogation, approximately 60% of cattle farms accounts for only 10% of cattle (*Figure 18*). Moreover, farms with less than 100 heads represents 83% of the total number of farms and account for 28% of cattle heads.

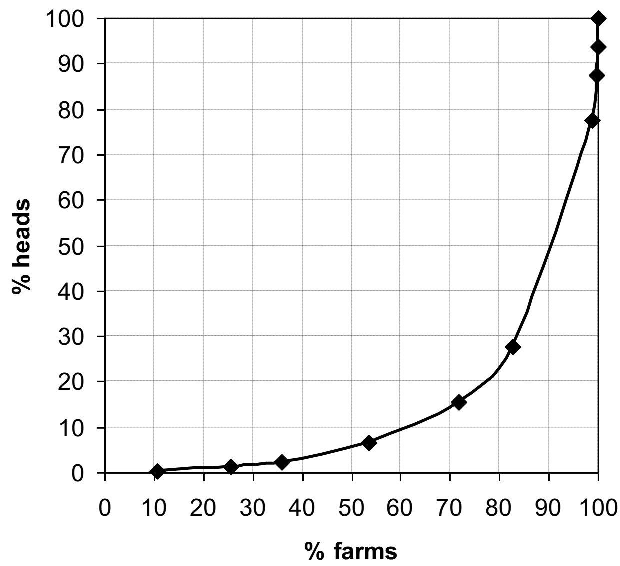


Figure 18 – Lorenz curve for cattle in the 5 regions applying for derogation.

With regard to pig sector Lombardy accounts for almost 50% of national production; with Emilia-Romagna (16%) and Piedmont (11%), these 3 regions account for more than ¾ of pigs reared in Italy.

Pig farms having less than 1000 heads are 87%; the remaining 13% accounts for 90% of the total number of pigs in Italy (*Figure 19*).

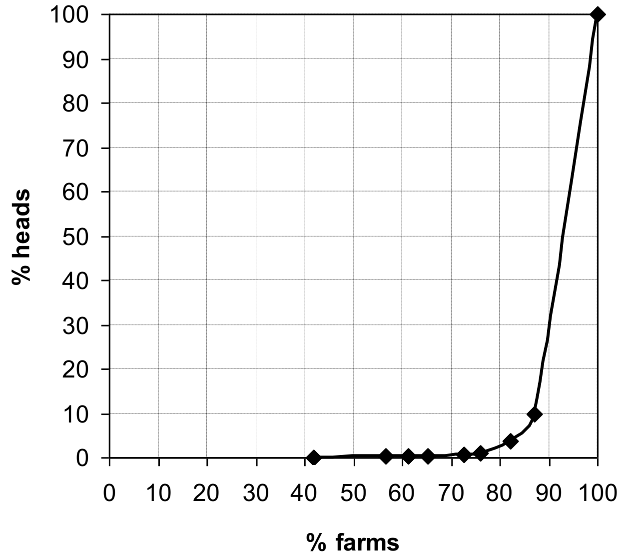


Figure 19 – Lorenz curve for pigs in the 5 regions applying for derogation.

With regard to poultry, Veneto accounts for 29%, Lombardy 24% and Emilia-Romagna 19% of the national total poultry number in Italy.

In the 5 regions of Northern Italy 76 million broilers and 29 million laying hens are reared. 10% of farms account for 77% of broilers; 3% of laying hen farms (exceeding 25000 heads) accounts for 90% of the total number of poultry heads (*Figure 20*).

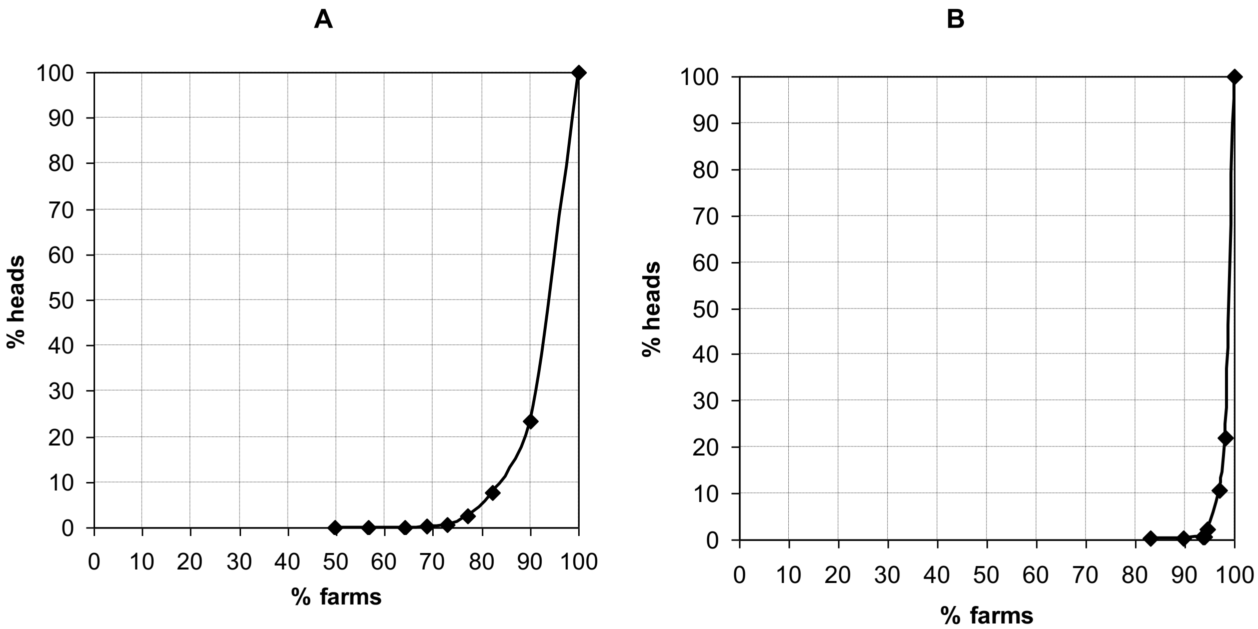


Figure 20 – Lorenz curve for broilers (A) and laying hens (B) in the 5 regions applying for derogation.

2.3.2 Characteristics of cattle and pig sectors

Cattle and pig production of Northern Italian Regions, compared to European Countries with similar level of intensity, is characterised by absence of grazing (cattle sector) and by predominance of fattening cycle up to a slaughtering weight of 150-160 kg (pig sector). Pig fattening was traditionally linked to cheese production, allowing utilisation of whey.

Cattle sector

a) Feeding techniques

From an interregional project and research activity carried out by CRPA and expert of 5 Regions (Bonazzi et al., 2004), the following main findings were obtained for dairy cattle:

- mean consumption of dry matter (DM) is approximately 6600 kg/cow x year, as an average of the values of the most productive Friesian cows and other local smaller breeds with a lower milk yield. About 90% of farms uses the Total Mixed Ration technique, which is known to promote higher feed ingestion compared to the more traditional feed provision techniques based on hay in winter and green forage in the other seasons;
- the mean content of crude protein in the diets is 15.3% of DM corresponding to a N content of 2.45%.

b) Housing and storage

Housing systems are different in the production area, respectively of Grana Padano and fresh milk production (mainly Piedmont, Lombardy and Friuli) and Parmigiano-Reggiano cheese (Emilia-Romagna and a small part of Lombardy), as shown in *Table 7* and *Table 8.*

Dairy cows	**(% of total heads)**
Tied stalls with bedding	5%
Cubicle housing	53%
Loose housing on a layer of bedding	42%
Dairy followers and calves for beef production	**(% of total heads)**
Tied stalls with bedding	2%
Loose housing on a layer of bedding on the total area	13%
Loose housing on a layer of bedding only in resting area	24%
Housing on total slatted floor	61%

Table 7 - Housing characteristics in the area of Grana Padano cheese production.

Housing typology	% of total heads
Tied stalls with bedding	58
Cubicle housing	25
Loose housing on a layer of bedding	17

Table 8 - Housing characteristics of dairy cattle in the area of Parmesan cheese production.

Housing systems with bedding are well represented in dairy cattle sector with 47% of heads in Grana Padano cheese production area and 75% of heads in Parmigiano-Reggiano cheese production area.

They include either tied systems, which represent still 53% of heads in the small traditional farms of the Parmigiano-Reggiano cheese production, and loose systems, either as i) deep litter only in resting area and ii) bedding on the total area on slope and slow flow of the litter to a collection channel.

Farmers are currently adapting storage capacity to the requirements of the action programmes, by constructing slurry tanks, covered in several cases.

Storages for solid manure are being constructed to comply with the action programme requirement of 90 day storage on tight platform with collection of drainage.

Pig sector

a) Feeding techniques

As previously highlighted the heavy pig production aimed at very high quality ham production (i.e Parma ham, San Daniele ham) is predominant in Northern Italy, with slaughtering weight around 160 kg of Live Weight (LW).

The feeding practice is mainly based on grain cereals meal, silage maize, oil seeds meals, by-products from sugar beet, roughage, by products from milk factories such as whey and by-products from distilleries. Usually ad libitum feeding (dry form) is typical of the growing phase up to 80-90 kg of LW. In the next phase (finishing, up to 160 kg of LW) feedstuff is usually provided in liquid form, mixed with water or whey.

It is highlighted that heavy pig production linked to high quality ham industry put tight constraints on farmers, concerning, for instance, the age and live weight of pig at slaughtering, which shall be, respectively, at least 9 months and 160 kg. This influences the number of rounds per year in fattening farms, which is on average 1.60 ± 0.2, and the feeding plans with decreasing level of crude protein during fattening. Average crude protein content in diet is 14,9% and feed conversion rate is approximately 3,9 (data referred to a fattening cycle from 32 to 163 kg).

b) Housing, manure management and storage

In *Table 9* data concerning housing systems related to the 5 Regions of Northern Italy are presented.

	Housing and manure removal systems*							
	1)	2)	3)	4)	5)	6)	7)	Total
Weaners	8.5	-	27.0	16.0	35.0	13.0	0.5	100.0
Growing pigs and fatteners	20.0	35.5	22.0	21.5	-	-	1.0	100.0
Gestating sows	23.6	13.0	15.3	9.0	39.0	-	0.1	100.0

Table 9 – Housing and manure removal systems (% of LU)

* Legend:
1) Solid Concrete Floor
2) Internal solid concrete floor and external slatted alley
3) Fully Slatted Floor (FSF)
4) Partially Slatted Floor
5) Flat decks for weaners or individual pen for sows with FSF above a slurry channel
6) Flat decks with FSF and water flush to remove manure
7) Solid Concrete Floor with litter

Data show that internal concrete floor with external slatted alley is the most represented housing type in the growers/finisher sector, where 75 to 80% of live weight is kept. Fully Slatted Floor is also well represented (22%), allowing to reduce water use for washing and slurry volume to storage at a minimum.

In the Northern Italian Regions storage capacity of pig slurry exceeds, on average, the 6 months required by the national and regional regulations. On the contrary, the 90 day storage capacity for solid manure (solid fraction from solid/liquid separation), is not complied with, yet.

All the new slurry storage vessels are concrete tanks.

2.3.3 Manure treatments

Centralised anaerobic digestion plants

Anaerobic digestion is expanding strongly in Italy, and about 200 units are operating with livestock manure, usually mixed with agricultural residues and energy crops. Operational plants have been constructed almost exclusively in the Northern regions, where the highest livestock density occurs.

Plant management in the responsibility of consortia of farmers are strongly supported by Italian Authorities (see paragraph 3.1). Consortium is in charge of all the operations of manure and energy crop collection, treatment operations, energy production and utilisation, transport and spreading of treated manure on land of the farmers participating in the consortium, this latter operation in co-operation with the farmers themselves.

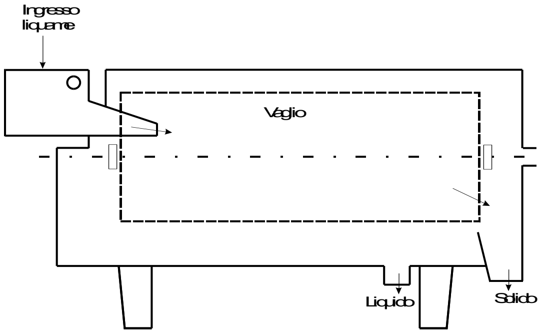
In landspreading operations treatment plant manager, in co-operation with the farmers, is obliged to comply with all the requirement of the Action Programme and the fertilisation plan.

Solid-liquid separation techniques

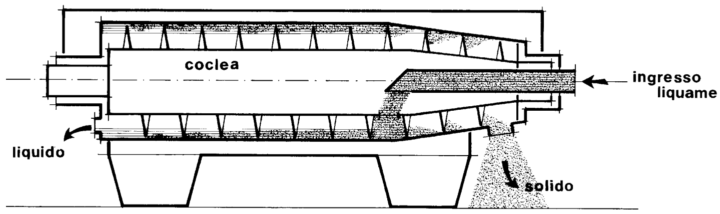
Solid-liquid separation is widespread in Italian farms for several purposes:

- control herbage soiling in order to reduce hygienic risks, in case of application of manure on grassland and other growing crops;
- remove nutrients from the clarified fractions and export the solid fraction (which concentrates organic nitrogen and phosphate) outside the farm, in case of nutrient surplus;
- improve manure management (storage, transport, pumping and spreading), for instance to avoid risk of clogging;
- facilitate handling in case flushing on alleys or channels is applied to remove manure to pits.

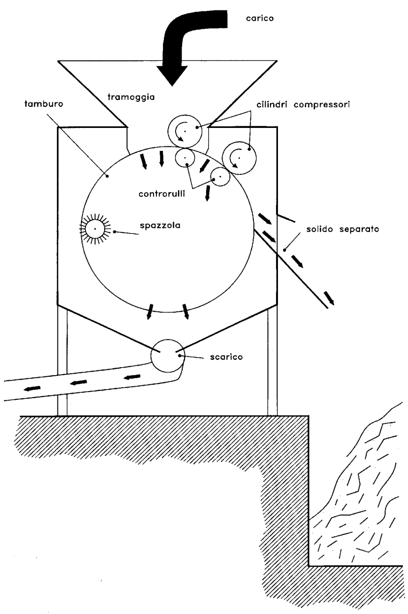
A wide range of mechanical separators are available on the market in Italy, at various costs and with different separation efficiency: rotary screen, sieve drum press, screw press, centrifuge, as shown in *Figure 21.*



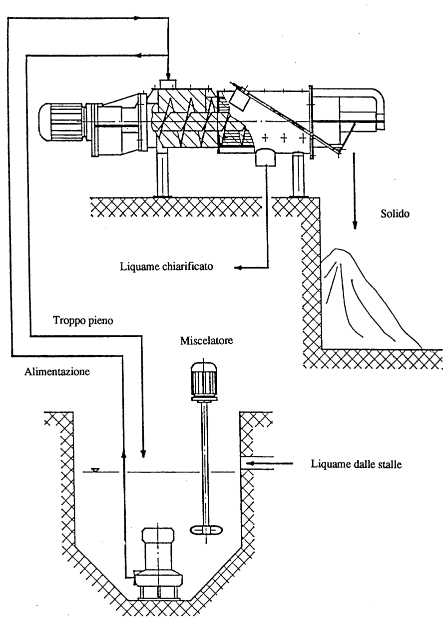
Rotating screen



Centrifuge



Sieve drum press



Screw press

Figure 21 - Examples of the most common separators.

Investment costs for separators vary very widely, reflecting sophistication and efficiency of the equipments. Sieve separators, which cost approximately 30,000 Euro, including pumping and mixing devices are the less expensive. Centrifuges, which cost around 120,000 Euro, are placed at the upper level of the range.

Separation efficiency and energy consumption are influenced by several factors:
- type of separator;
- sieve mesh size (or centrifugal force);
- manure type and previous treatments (anaerobic digestion, ...);
- use of additives;
- total solids in manure.

Data on the efficiency of the different separators in treatment of raw cattle and pig liquid manure have been recorded in full scale farms (Balsari et al., 2006; CRPA, 2001). The highest efficiency is achieved with decanter centrifuges, in particular in removal of suspended solid and phosphate (up to 70-75% in the solid fraction). However, at present, this device is only seldom used in livestock farms, due to the high investment and maintenance costs and also to operational difficulties.

Relatively good efficiency in nutrient removal in the solid fraction can be achieved by screw press. This type of equipment is considered simple and reliable by Italian farmers, suitable for the needs of a wide range of farms. Similar efficiency is achieved by sieve drum press.

Regions of Northern Italy, through RDPs 2007-2013, supported solid liquid separation devices, according to a strategy of reduction of nutrient surpluses by exporting solid fractions from intensive livestock area to area characterised by low organic matter in soil or simply needing fertilisation, in order to improve fertility.

The efficiency in nitrogen removal can be slightly lower in case of anaerobically digested slurry, due to increased proportion of mineral N, on which physical separation has little effect.

In trials carried out by the University of Turin (Balsari et al., 2006), on fresh pig slurry characterised by low N/P_2O_5 ratio, clarified fractions with $N/P_2O_5 > 2.5$ were obtained using a screw press, a sieve drum press and a centrifuge (*Table 10*). The screw press can guarantee the higher N/P_2O_5 ratio in the clarified fraction if the treated slurry is not too dilute.

		Screw press		**Sieve drum press**	**Centrifuge**
Treated slurry	m^3/h	19	16	25	2
Raw fresh pig slurry (input)					
DM	%	3.4	4.6	3.4	3.4
TKN	%	0.43	0.42	0.43	0.43
P_2O_5	%	0.23	0.34	0.23	0.23
N/P_2O_5	-	1.87	1.24	1.87	1.87
Clarified fraction (output)					
DM	%	2.8	2.2	2.5	1.9
TKN	%	0.41	0.40	0.42	0.39
P_2O_5	%	0.20	0.11	0.13	0.10
N/P_2O_5	-	2.05	3.64	3.23	3.90
Solid fraction (output)					
DM	%	26.6	25.1	27.1	27.9
TKN	%	0.72	0.64	0.67	1.04
P_2O_5	%	1.15	2.24	2.85	2.39
N/P_2O_5	-	0.63	0.29	0.24	0.44

Table 10 – Efficiency of the most common separators used in Northern Italy on pig slurry

Data in *Table 11* show an estimate of the number of the most common separators in pig and cattle farms. Estimates were provided by Farmers Unions and local Authorities responsible for permits.

Farm type	n. of farms with separation equipment	% of total
Cattle farms total n.	**65495**	
Rotating screen	-	-
Sieve drum press	900	1.5
Screw press	2500	4
Decanter centrifuge	-	-
Pig farms total n.	**13422**	
Rotating screen	4500	33
Sieve drum press	300	2.2
Screw press	500	3.7
Decanter centrifuge	100	0.7

Table 11 - Separation devices in animal farms of Northern Italy

2.4 Fertiliser utilisation

In line with reduction of overall livestock number, livestock manure production is also decreasing as well as the use of mineral fertilisers.

In 2007 the 5 regions of Northern Italy applying for derogation accounted for 56% of mineral fertilisers, 62% of soil amendments and 94% of soil conditioners sold in Italy, corresponding to 59% N (650 million kg in Italy) and 50% P (210 million kg P_2O_5).

In the period 1979-2008 (*Figure 22*), even if with some inter annual fluctuation, N consumption declined substantially; in the period 1998 al 2004 a slight increase took place, while, since 2004 a trend in decrease of fertiliser N consumption is recorded.

The improvement of fertilisers utilisation in agriculture is mainly addressed through advisory services, soil analysis, fertiliser advice to farmers and through agro-environmental measures of the RDPs and other funding mechanisms established at regional level.

The success of the approach adopted in optimising fertilisers utilisation is demonstrated by the constant and significant decline in the utilisation of mineral P fertilisers in Italy (*Figure 23*).

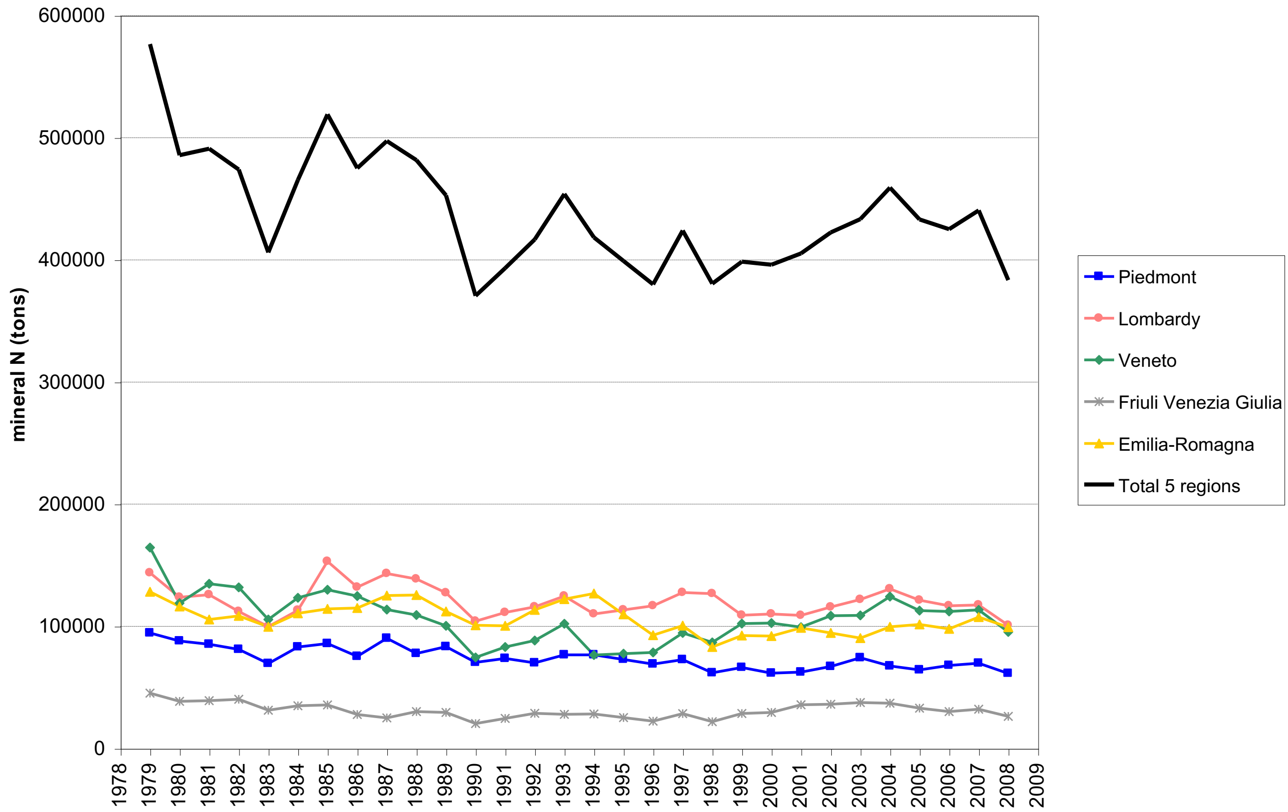


Figure 22 – Mineral nitrogen consumption from 1979 to 2008 (CRPA elaboration from ISTAT data).

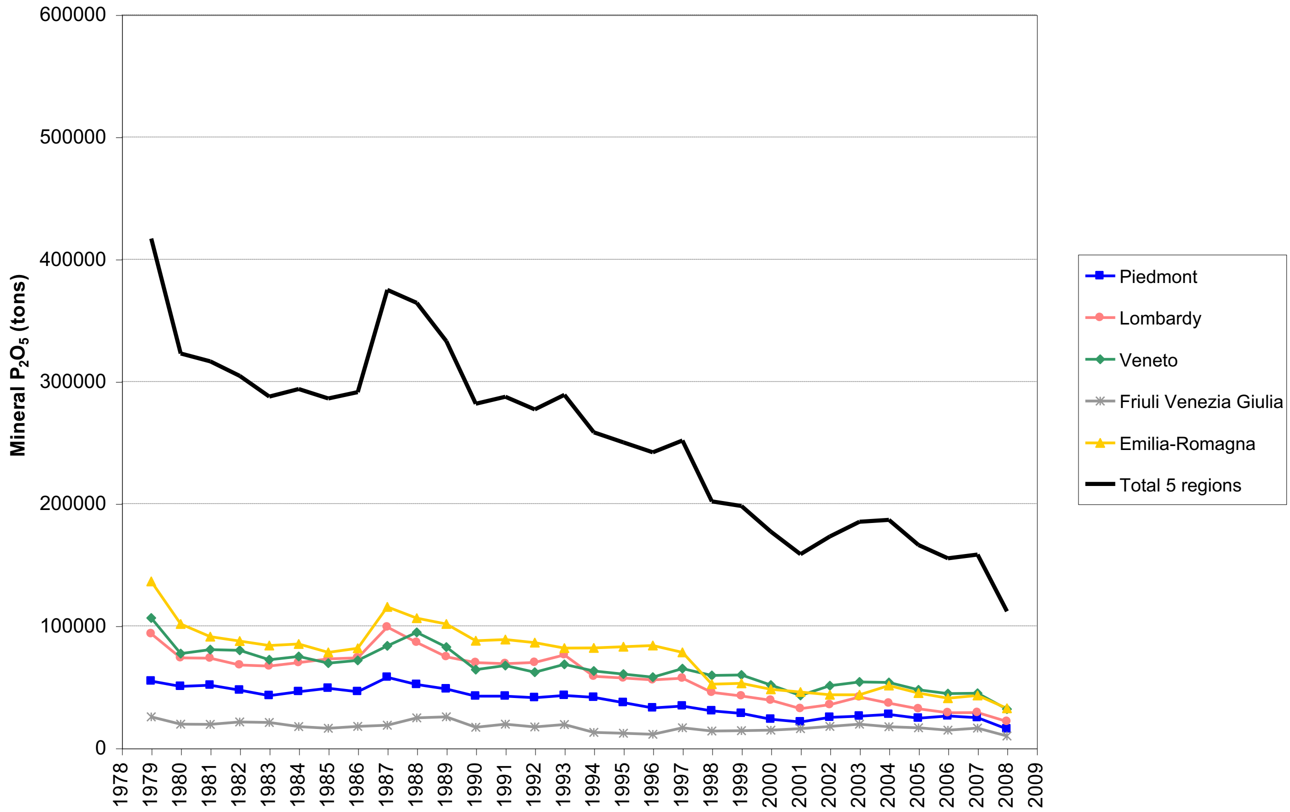


Figure 23 – Mineral P_2O_5 consumption from 1979 to 2008 (CRPA elaboration from ISTAT data).

2.5 Climatic conditions

2.5.1 Temperature and rainfall

Climate is characterised by hot, humid summer and relatively cold winter. These conditions are favourable to long growing seasons. Average temperatures for the coldest and the hottest months are represented in *Figure 24.*

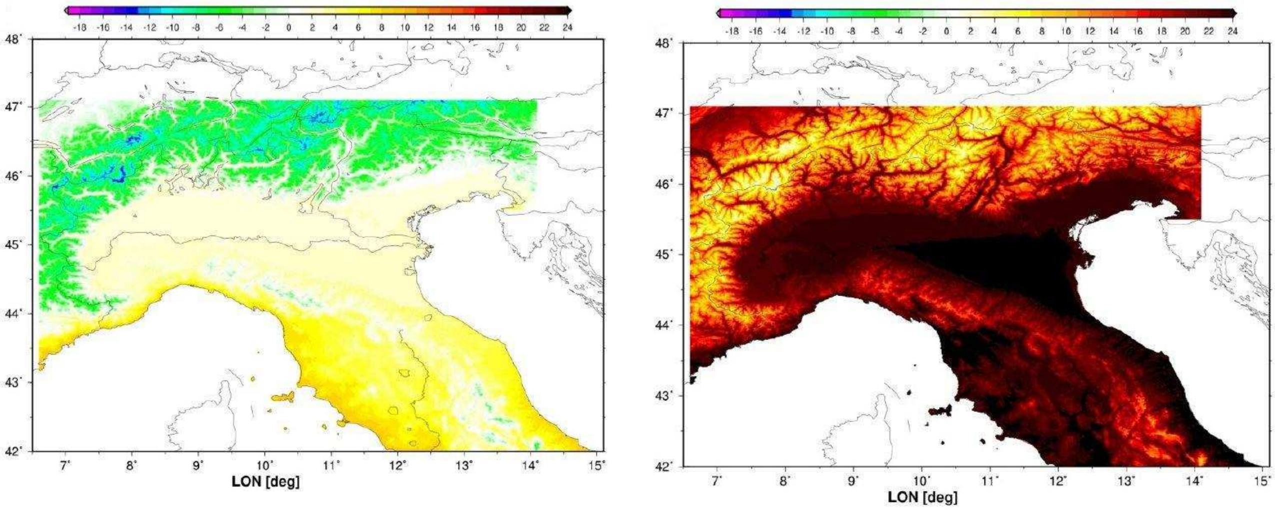


Figure 24 – Monthly average temperature registered in January (A) and July (B). Reference period 1961-1990 (Brunetti et al., 2009A).

Average annual temperatures of 12 to 14 °C are recorded in the plain of the river Po Valley, while lower temperatures are recorded at the foothills (10 to 12 °C°) (*Figure 25*).

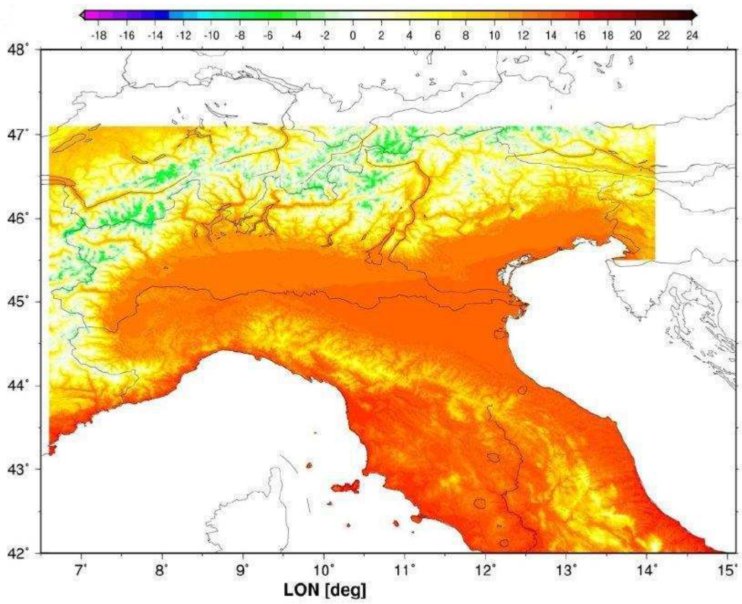


Figure 25 – Annual average temperature. Reference period 1961-1990 (Brunetti et al., 2009A).

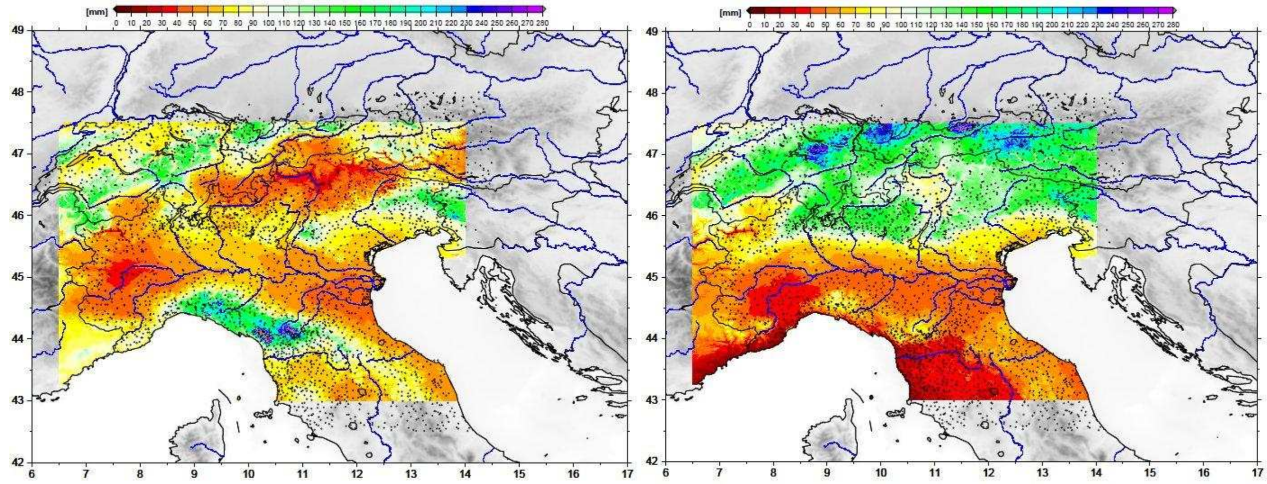


Figure 26 – Monthly rainfall registered in January (A) and July (B). Reference period 1961-1990 (Brunetti et al., 2009B).

Rainfall ranges from 500-600 mm in the eastern area of Emilia-Romagna, around the Po river delta, to 800 a 1000 mm in the western area of the Po Valley and at the foot hills, with much higher values in the Alps and Apennines (*Figure 27*).

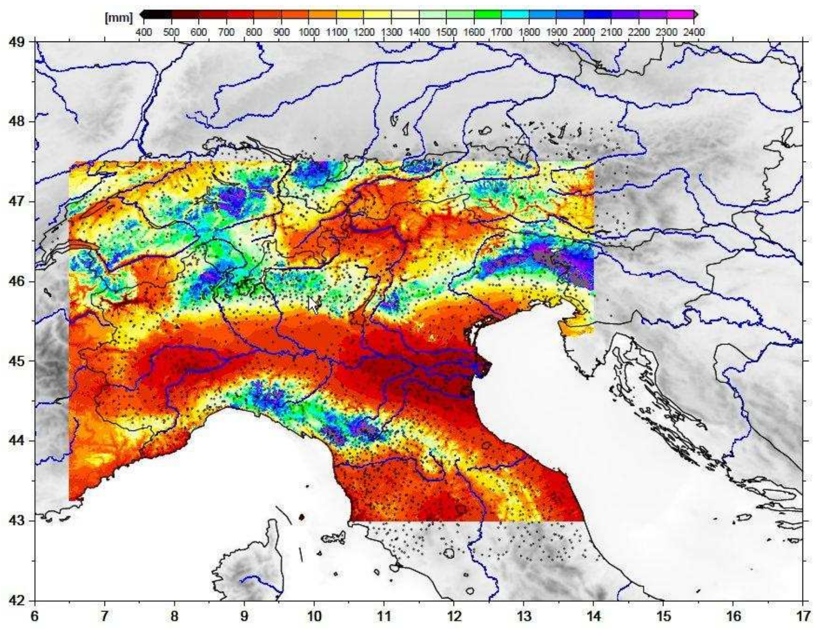


Figure 27 – Total annual rainfall. Reference period 1961-1990 (Brunetti et al., 2009B).

2.5.2 Agroclimatic features

Climate in northern Italy according to Köppen climate classification is mainly "Humid subtropical" (Cfa). This climate lies on the south-east side of all continents, roughly between latitudes 25° and 40° north and south. The Po Valley is one of the few exceptions where this climate zone reaches up to latitude 46° north (*Figure 28*).

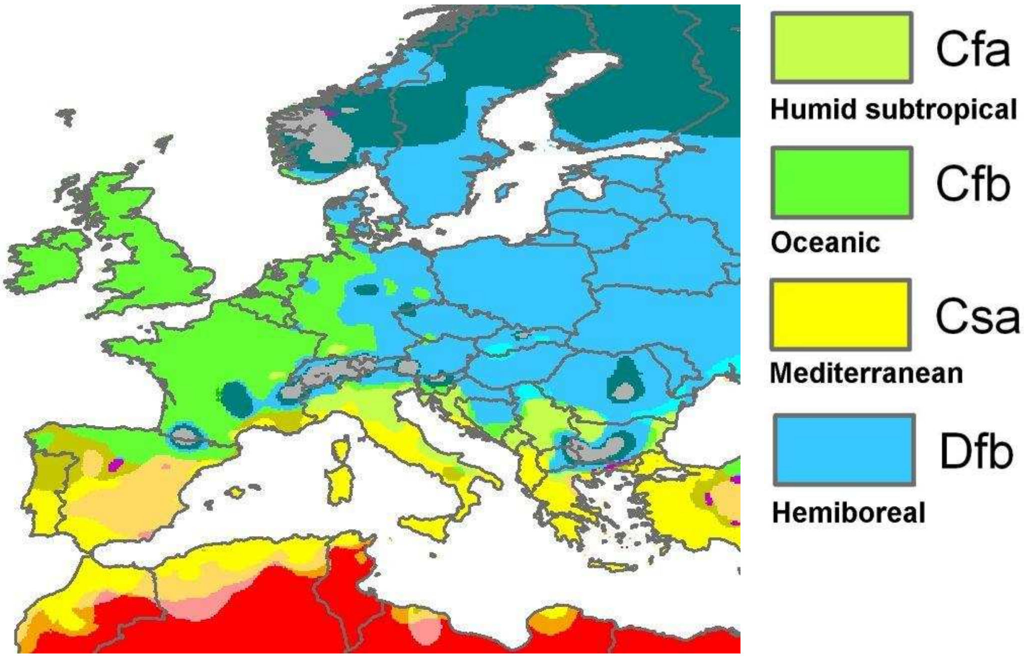


Figure 28 – Europe map of Köppen-Geiger climate classification.

Agroclimatic features of Italy were calculated by Perini et al. (2004) using data from the National Agroclimatic Data Bank (BDAN), for a standard period (1961-1990) according to WMO recommendations and estimated with Kriging's techniques. The dataset is composed of complete series of daily values: temperature (minimum and maximum), rainfall, sunshine, relative humidity and wind speed of 544 Italian sites homogeneously disseminated in a regular grid (30 x 30 km).

Temperature data permit the calculation of the length of the **Growing Season** (GS), defined as the period of the year with daily mean temperature equal or higher than a specific threshold. The GS is characterised by a start (the first day of the year, before 31 August, followed by a period of at least 15 days with mean temperature equal or higher than the selected threshold) and end (the first day of the year, after 1st July, followed by a period of at least 15 days with mean temperatures lower than the selected threshold) and a duration (number of days between the start and the end of the GS).

In 90% of the area, growing season starts beginning of March and ends in November, extending until December in some areas of eastern Piedmont, western Lombardy and in the plain nearby Adriatic Sea (*Figure 29*). Growing season exceeds 250 days on at least 80% of Northern Italy, reaching 300 days in some areas, for instance in Southern Friuli Venezia Giulia.

This is confirmed by the estimate of Brereton et al. (1996) who calculated growing period between 250 and 300 days in a large area across Europe including the whole plain area of the Northern Italy.

Monthly average rainfall are shown in *Figure 30*, based on National Agroclimatic data bank (BDAN). Annual average rainfall spans from 1100 mm/year in Friuli Venezia Giulia to 800 mm/year in Emilia-Romagna.

Maximum rainfall, above 100 mm/month are recorded in late spring (May-June) and Autumn, while colder months of January and February also record relatively low precipitation, less than 50 mm/month.

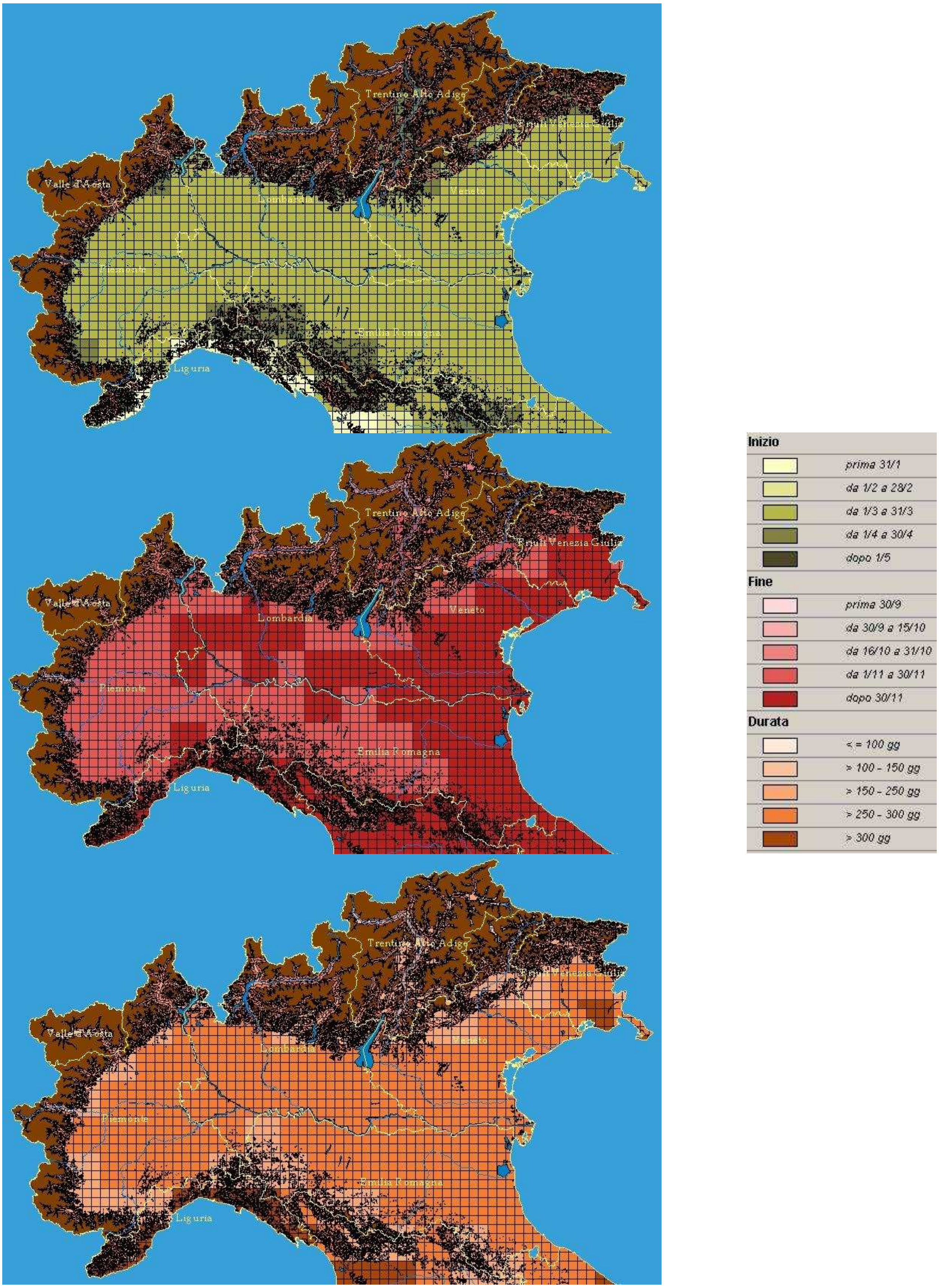


Figure 29 – Start data, end data and duration of the Growing Season. Brown are areas above 1500 m asl, black are areas with slope > 30% (Perini et al., 2004).

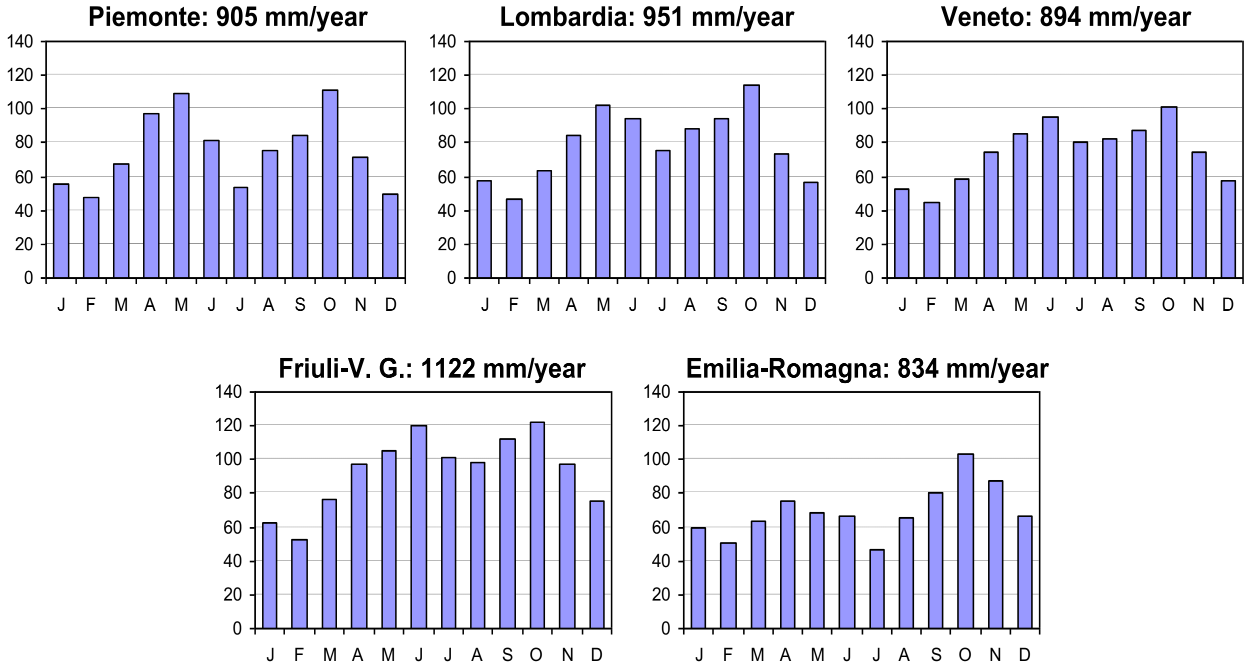


Figure 30 – Monthly rainfall for the 5 regions (from BDAN-SIAN Roma)

2.6 Soil characteristics

2.6.1 Soil types

Soils have good productivity potential but medium to low organic matter (especially in some areas). In general they are fine textured with medium-high pH and a good capacity in P retention.

The main soil types in plains of Northern Italy are (see *Figure 31*):

Bd	Dystric Cambisol
Be	Eutric Cambisol
Bef	Eutri-fluvic Cambisol
Bv	Vertic Cambisol
Bk/Bkh	Haplic Calcisol
Jeg	Eutri-gleyic Fluvisol
Lg/Lgp	Gleyic Luvisol
Lo	Haplic Luvisol
Oe	Eutric Histosol
Rc	Calcaric Regosol

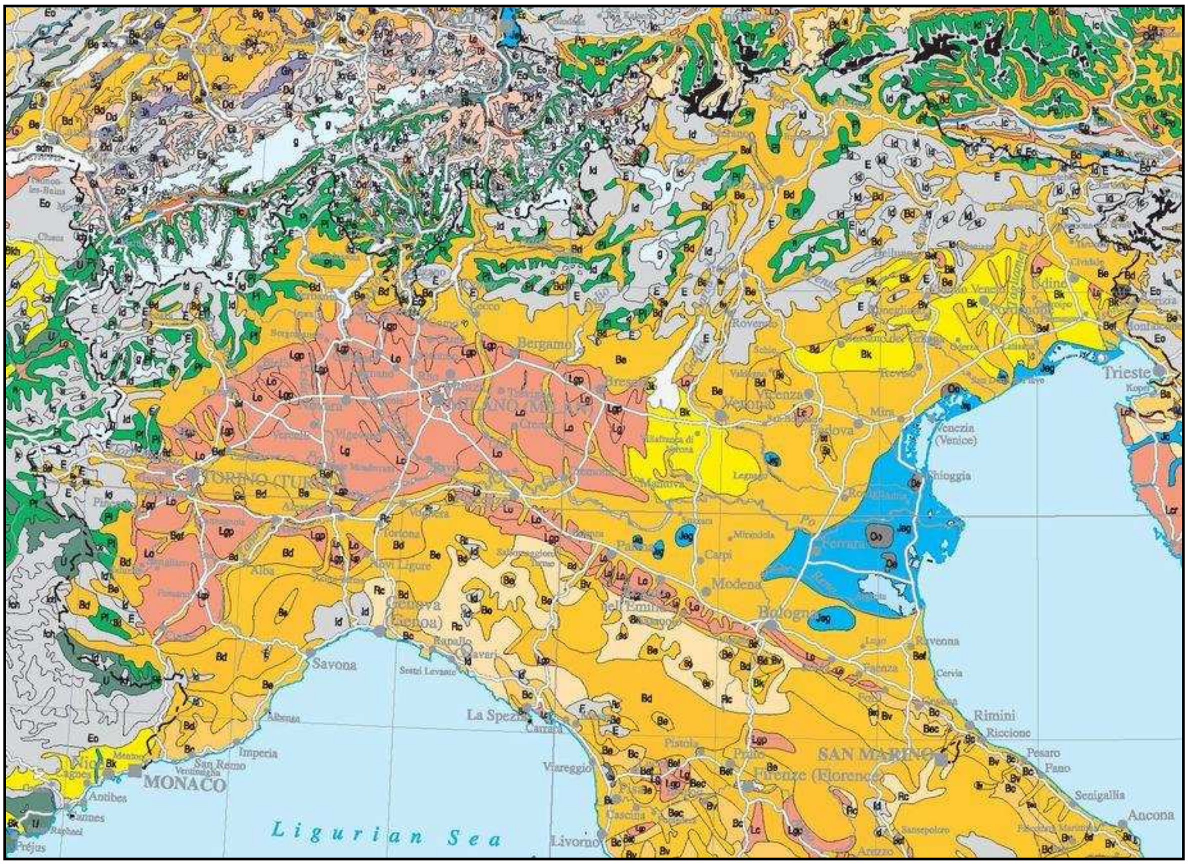


Figure 31 - Soil map of Northern Italy (from Soil Atlas of Europe - JRC)

A Cambisol is a young soil, only moderately developed on account of limited age or rejuvenation of the soil material (from the Latin *cambiare* meaning to change).

In Northern Italy **Distic Cambisols (Bd)**, having in at least some part between 20 and 100 cm from the soil surface a base saturation (in 1M ammonium acetate at pH 7.0) of less than 50%, are widespread in particular in some hilly and plain areas of Piedmont and Veneto.

Eutric Cambisols (Be), having in at least some part between 20 and 100 cm from the soil surface a base saturation (in 1M ammonium acetate at pH 7.0) of more than 50%, as for Distic Cambisols are diffused in some hilly areas of the five regions considered in this report, in particular in Lombardy (Prealps) but also in Emilia-Romagna (Apennines).

Eutri-fluvic Cambisols (Bef), having within 100 cm from the soil surface, fluvic soil material, characterise the main part of the low plain in the Emilia-Romagna and Veneto regions.

Vertic Cambisols (Bv), having a vertic horizon or vertic properties within 100 cm from the soil surface, characterised some hilly areas of the Emilia-Romagna region (especially Romagna Apennines).

A Calcisol is a soil with significant accumulation of secondary calcium carbonates (from the Latin *calcarius*, meaning calcareous or lime-rich).

In Northern Italy **Haplic Calcisols (Bk)**, having the typical expression of the Soil Reference Group in the sense that there is no further specific characterisation, are diffused in some large plain areas of the north-east.

A Fluvisol is a young soil in alluvial (floodplain), lacustrine (lake) and marine deposits (from the Latin *fluvius*, meaning river).

In Northern Italy **Eutri-gleyic Fluvisols (Jeg)**, having in at least some part between 20 and 100 cm from the soil surface a base saturation (in 1M ammonium acetate at pH 7.0) of more than 50% and gleyic properties (groundwater saturation) within 100 cm from the soil surface, characterise the reclaimed areas around the Po delta, the Venice and the Marano-Grado lagoons.

A Luvisol is a soil with a subsurface horizon of high activity clay accumulation and high base saturation (from the Latin *luere*, meaning to wash).

In Northern Italy **Gleyic Luvisols (Lg/Lgp)**, having groundwater saturation within 100 cm from the soil surface, are diffused in some high (Lgp) and low (Lg) plain areas, especially in Piedmont and Lombardy. **Haplic Luvisols (Lo)**, having the typical expression of the Soil Reference Group in the sense that there is no further meaningful characterisation, are diffused in some plain areas of the Piedmont and Lombardy and in high plain areas of the Emilia-Romagna.

A Histosol is a dark soil with high accumulation of partially decomposed organic matter generally developed in wet or cold conditions (from the Greek *histos*, meaning tissue).

Some little with **Eutric Histosols (Oe)**, having in at least some part between 20 and 100 cm from the soil surface a base saturation (in 1M ammonium acetate at pH 7.0) of more than 50%, are included into the areas characterised by Eutri-gleyic Fluvisols.

A Regosol is a very weakly developed mineral soil in unconsolidated materials with only a limited surface horizon having formed (from greek *rhegos*, meaning blanket). **Calcaric Regosols (Rc)**, calcareous at least between 20 and 50 cm from the soil surface, characterised some hilly areas of the Emilia-Romagna region (Emilia Apennines).

Nitrates Vulnerable Zones include mainly Luvisols in Piedmont, Lombardy and Emilia-Romagna, Cambisols and Calcisols in Veneto and Friuli Venezia Giulia; also the area with Fluvisols and Histosols, both in Emilia-Romagna and Veneto, has been designated as Nitrate Vulnerable Zone.

2.6.2 Organic matter content

Maps of the Organic Carbon content in topsoils in Europe have been elaborated by JRC. Maps related to Italy are reported in *Figure 32*.

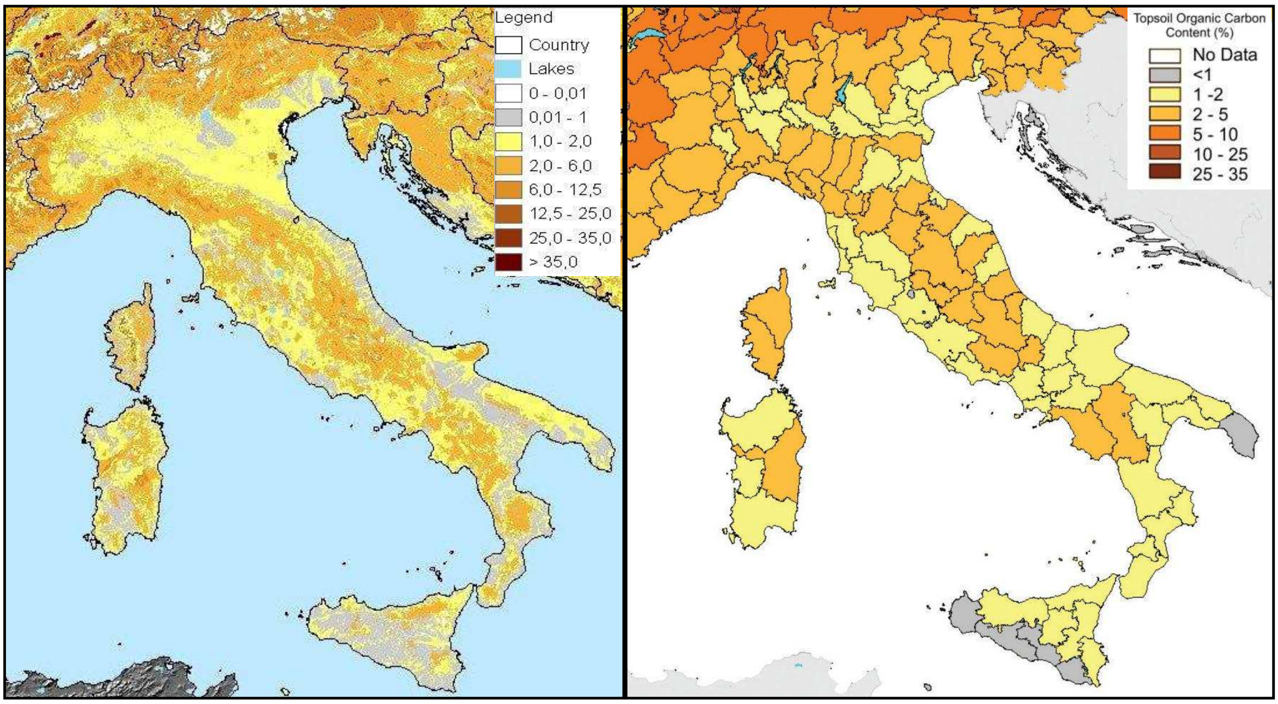


Figure 32 - Maps of the Organic Carbon content in topsoil in Italy (from JRC)

Organic matter in soil is measured as organic Carbon (OC) and the values are converted to OM content using a standard conversion ratio OC:OM of 1:1.72. The data from Italy, utilised by JRC to map OC content, derived from soil sampling, mainly from agricultural land. Furthermore, the sampling locations (approximately 6800) were strongly clustered in some areas.

The mean topsoil OC content resulted 1.2%. OC content in Italian soils is low, due to, as for the other Mediterranean countries, the dry conditions and high temperatures, especially in summer, which favour rapid mineralisation of OM. An imbalance between the build-up of soil organic matter and rates of decomposition is leading to a decline in soil organic matter contents in large area in Italy. This is causing increased soil degradation (loss of structure and fertility), erosion and, in some area, threat of desertification. Management practices through application of exogenous organic matter, such as livestock manure and compost, could help in counteracting OM decline induced by natural factors, such as climate and soil parent material and by land use.

Regions of the Po valley prepared their specific maps of the organic matter content in the topsoil based on detailed sampling programmes (*Figure 33*), showing that, even in these regions with intensive livestock farming, organic matter decline is an issue in some areas, which can, therefore, take advantage from periodic application of livestock manure.

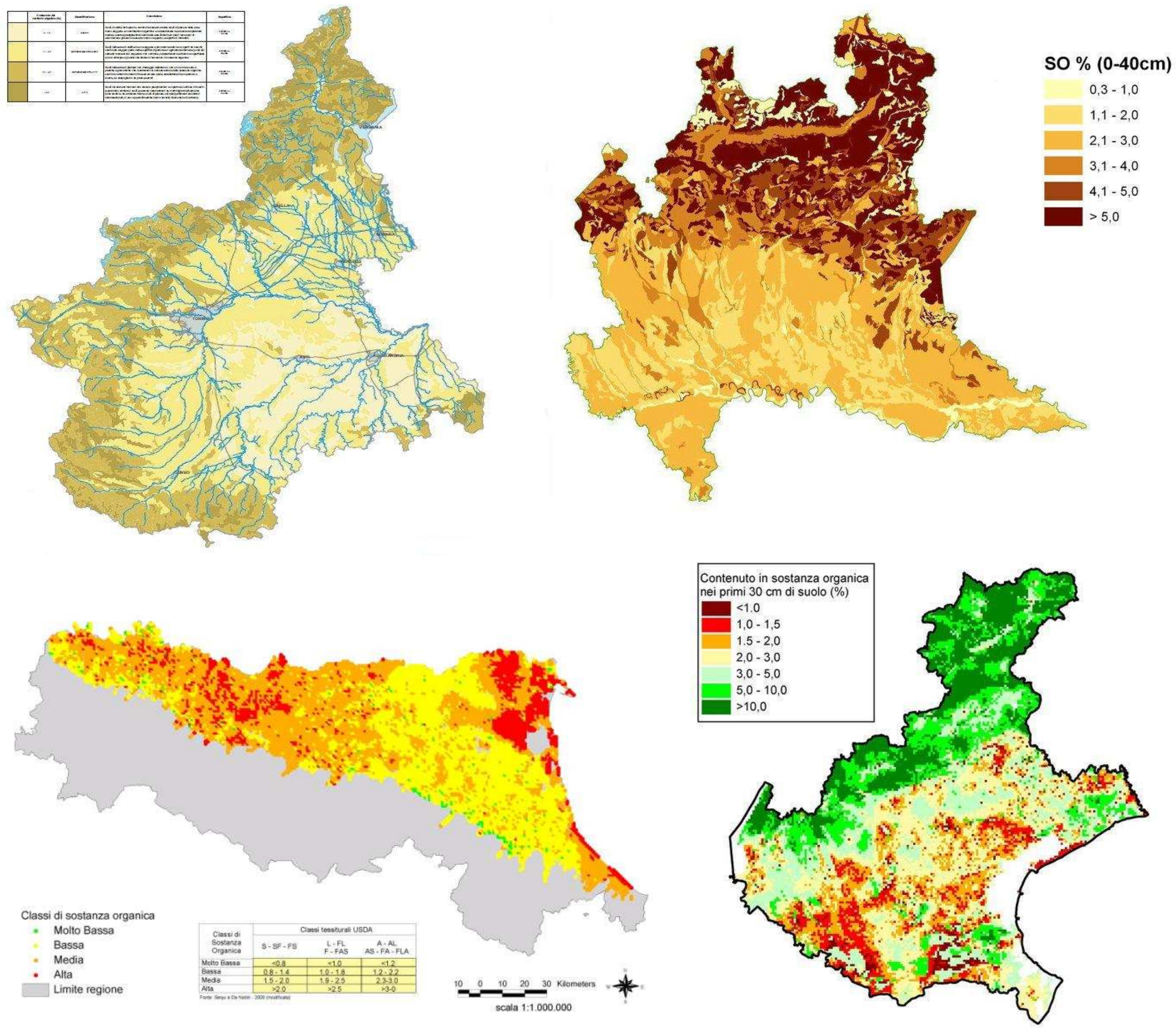


Figure 33 - Regional maps of the organic matter in topsoil (examples from Piedmont, Lombardy, Emilia-Romagna, only plain areas, and Veneto)

	Soils in Nitrate Vulnerable Zones				Soils in NON Vulnerable Zones			
	Very low OM	Low OM	Average OM	High OM	Very low OM	Low OM	Average OM	High OM
Piedmont	7.6	40.5	26.4	25.5	18.5	39.7	20.6	21.3
Lombardy	1.1	14.1	43.6	41.2	1.6	18.6	39.7	40.1
Veneto	1.0	36.5	27.5	35.0	1.4	41.0	36.4	21.2
Emilia-Romagna	0.2	28.4	49.2	22.2	0.2	35.1	52.0	12.7

Table 12 – Percentage of soils per Organic Matter classes (data from Regional Soil Services)

Legend

Organic matter classes	USDA soil texture classes		
	S, FS, FS	L, FL, F, FSA	A, AL, AS, FA, FLA
Very low	<0.8	<1.0	<1.2
Low	0.8-1.4	1.0-1.8	1.2-2.2
Average	1.5-2.0	1.9-2.5	2.3-3.0
High	>2.0	>2.5	>3.0

2.6.3 Soil texture, pH and phosphorus content

Soil characteristics such as texture and pH are reported, for each of the five regions, in the following *Table 13-Table 14*.

	Soils in **Nitrate Vulnerable Zones**			Soils in **NON Vulnerable Zones**		
	>60% sand	<60% sand <35% clay	>35% clay	>60% sand	<60% sand <35% clay	>35% clay
Lombardy	4	93	3	16	80	4
Veneto	4	89	7	4	78	18
Friuli Venezia G.	0	89	11	1	98	1
Emilia-Romagna	6	76	18	2	69	29
Piedmont	0	98	2	1	95	4

Table 13 – Percentage of soils per texture classes (data from Regional Soil Services)

	Soils in **Nitrate Vulnerable Zones**			Soils in **NON Vulnerable Zones**		
	Acid <6.6	Neutral >6.6 <7.3	Alkaline >7.3	Acid <6.6	Neutral >6.6 <7.3	Alkaline >7.3
Lombardy	24	21	55	51	17	32
Veneto	3	5	92	0	2	98
Friuli Venezia G.	0	30	70	1	9	90
Emilia-Romagna	4	12	84	1	1	98
Piedmont	57	16	27	43	8	49

Table 14 – Percentage of soils per pH classes (data from Regional Soil Services)

With respect to P content in soils in the Po valley, the regional databases on Olsen-P concentration have been considered. Olsen-P extraction is an accepted methodology for estimating P availability and developing fertiliser recommendations (Olsen et al., 1954).

The agronomic threshold of sufficiency indicated by the advisory services spans between 15 and 25 mg/kg P Olsen, depending on crop and soil types (Westermann et al., 2001; Turan et al., 2009). With reference to an average value of 20 mg/kg soil available P (P Olsen), this value is achieved or exceeded in approximately 30% of soil samples in Emilia Romagna region and in approximately 50% of soil samples in Piedmont, Lombardy and Veneto regions. In these areas P fertilisation needs to be controlled in order to avoid any further increase in soil P availability, especially where values exceed 20 mg/kg P Olsen.

The characteristics of the Po valley climate, soils, and land use, as in many cases in southern Europe, result in P transfer from agricultural soils through runoff rather than in drainage water (Torrent et al., 2007). Adoption by farmers of soil conservation measures and other good agricultural practices in order to prevent losses through erosion is essential. These practices are disseminated through advisory services and also promoted through RDPs.

3. Key elements and basic conditions of the Italian derogation request

3.1 Type of derogation

Italy asks for a derogation to be granted to farms, on an individual basis, with at least 70% crops with high N demand and long growing season.

Derogation will apply to cattle manure and to other manure types provided that they fulfil the conditions set out in paragraph 3.2.

A specific case for derogation would address treated manure from centralised plants (i.e. anaerobic digestion plants). Derogation in this latter case would be requested by the legal representative of the treatment plant on behalf of farmers participating in the consortium, who have to sign a contract for a minimum of 4 years. The legal representative of the co-operative plant would take the responsibility of preparing the derogation request on behalf of livestock farmers who supply manure to the co-operative plant and/or of farmers who receive treated manure. The co-operative treatment plant would also be responsible for some specific phases of manure treatment and utilisation (i.e. anaerobic digestion process, solid/liquid separation, raw and treated manure transport and, possibly, manure spreading). This type of derogation will be relevant as the Italian Authorities, with the aim of improving manure management and production of renewable energy, in line with the relevant EU policy, are supporting anaerobic digestion from livestock manure, including through co-operative plants.

Manure management through large co-operative treatment plants would allow application of advanced techniques for manure treatment, including control of ammonia and GHG emission, improve the possibility of controls in the transport phase (i.e. through compulsory GPS on trucks) and facilitate introduction of low emission spreading techniques. Overall, co-operative treatment would substantially improve the possibility of controls of manure management by the competent Authorities.

3.2 Manure types eligible for derogation

Manure types eligible for derogation, are:

1) Cattle manure

2) Clarified fractions of pig slurry

Clarified fractions from solid/liquid separation of pig manure shall comply with the following conditions:

a) solid/liquid separation shall ensure that N/P_2O_5 ratio is 2.5 or higher in the clarified fraction. The 2.5 value well corresponds to the ratio between N and P_2O_5 in the main crops allowed in derogation farms (see next paragraph and chapter 4 for details) and ensures that application of P does not exceed crop requirement when nitrogen in manure corresponding to crop uptake is applied;
b) ammonia and other emissions from pig manure treatment shall be controlled to minimise pollution swapping effects;
c) additional treatments to remove N from clarified fraction are not allowed in areas with risk of salinisation;

d) the competent Authorities communicate to the European Commission the methodologies established to assess the separation efficiency and the composition of the resulting fractions. Efficiency of solid/liquid separation is evaluated through mass balance;

e) low emission techniques shall be used for manure spreading.

3) Other types of manure

Other manure are eligible for derogation provided that the ratio N/P_20_5 is equal or exceeds 2.5. This could be the case, for instance, of clarified fractions from anaerobically digested manure from co-operative plants treating manure from different livestock categories.

3.3 Cropping systems eligible for derogation

Crops eligible for derogation shall guarantee high nitrogen uptake and long growing season. In Northern Italy these conditions are met by the following crops:

- *Maize (late maturing hybrids, whole plant to be harvested);*
- *Maize + winter herbage (to be harvested);*
- *Winter cereal + summer herbage (to be harvested);*
- *Permanent and temporary grassland (with less than 50% of leguminous plants);*
- *Other crops with a N uptake of at least 250 kg/ha/y and long growing season (for instance grain sorghum + winter herbage).*

More details are reported in chapter 4 (Justification for the intended derogation).

Concerning maize without a cover crop, derogation from the limit of 170 kg/ha manure N is justified in the climatic and agronomic conditions of Northern Italy, if we consider:

a) Length of the growing season: temperature and water availability for irrigation in the plains of Northern Italy are suitable for maize varieties with a relatively long growing cycle with respect to active soil mineralisation. Growing cycle of maize class FAO 600-700 (late or very late maturing hybrids), planted mid March / beginning of April has a length of at least 145-150 days , due to its need of at least 1500 Growing Degree Days for ripening. Maize growing season corresponds to the period of active mineralisation of soil organic matter.
To guarantee a growing season of 5 months, non limiting water availability for plant growth must be provided, often through irrigation.

b) Crop with high N uptake: maize without a cover crop fulfils the requirement of high N uptake in the conditions of Northern Italy, due to the productivity levels achieved in the plains. It is necessary that the whole plant is exported from the field (including stalks and cobs in case of grain production), in order to achieve average uptake exceeding 250 kg N/ha, which is the proposed threshold for “high N uptake”.

c) High N efficiency: nitrogen use efficiency (NUE), evaluated through the ratio between N uptake by the crop and total N input from animal manure shall be 0.65 or higher (0.50 for FYM). In order to achieve this efficiency good agricultural practices shall be implemented with regard to timing of spreading and splitting of N application. Good fertilisation practice allows to achieve low mineral N residues in soil at the end of the growing season.
For these reasons, fertilisation will be permitted only just before sowing or during the growing season (up to June).

Other elements supporting the derogation request for maize and the other crops can be found in chapter 4 (Justification for the intended derogation).

3.4 Standards for fertiliser application in derogation farms

The quantity of N from manure and chemical fertilisers applied to land in derogation farm shall not exceed an amount determined by reference to the foreseeable nitrogen requirements of crops.

Legally binding maximum N application rates with fertilisers (organic fertilisers and mineral fertilisers) in derogation farms are set at the levels shown in the table below. Manure N application limit in derogation farm is set at 250 kg per hectare per year for all crops, although field scale studies and results from modelling have demonstrated that a fertilisation level up to 280 kg N per hectare per year in maize based cropping systems would not increase N release to water bodies.

Crop	**N crop uptake (kg/ha)**	**N from manure (kg/ha)**	**N from mineral fertilisers* (kg/ha)**
Maize FAO 600-700	270	250	85
Maize + winter herbage	300	250	115
Winter cereal + summer herbage	270	250	85
Permanent and temporary grassland	300	250	115
Other crops with high N uptake and long growing season	250	250	65

Table 15 - Maximum standards application rates for nitrogen in derogation farms

* This threshold corresponds to the total maximum N application through mineral fertilisers, assuming available N from liquid manure = 0.66 and efficiency from chemical fertilisers = 1. The contribution of 20 kg/ha N from atmospheric deposition has been considered as an additional N input.

In case of FYM the lower efficiency (0.50 vs. 0.66) shall be taken into account in setting N from mineral fertilisers.

In case the farmer can demonstrate that N uptake exceeded the standards, on the basis of documented data on yield and N content in crops, this latter certified with crop analysis, the values in this column can be increased by maximum 15%.

3.5 Solid/liquid separation of manure and export of solid fractions

a) The solid fractions from solid/liquid separation shall be exported from the derogation farm. In case these fractions are used in Nitrate Vulnerable Zones, P application shall not exceed the crop need, calculated on the basis of the crop rotation, by more than 15%;

b) in case the solid fractions are used on acid or neutral soils outside Nitrate Vulnerable Zones, P application shall not exceed crop need, calculated on the basis of the crop rotation, by more than 15%;

c) the solid fractions should be preferably treated in authorised plants for fertilisers or energy production. Utilisation on land outside Nitrate Vulnerable Zones should preferably take place on soil with low organic matter (<2%);

d) farms applying for derogation shall ensure that transport of solid fractions outside NVZs is registered through GPS systems and effluent composition - in relation to Total Solids, N and P - is verified through sampling and analysis for each individual lot. Results of analysis shall be communicated to the receiver and to the competent authorities.

Most Italian soils, as described in chapter 2, have an average low organic matter, in particular, in Northern Italy, in the area where livestock farming has been abandoned in favour of other farming systems, and in most of Central and Southern Italy. Therefore, utilisation of solid fractions from solid/liquid separation of manure outside the derogation farms will be easily achieved, provided that a good stabilisation is obtained through storage and/or treatment.

4. Justification for the intended derogation

4.1 Scientific elements of derogation

The following three cropping systems are presented:

1. Maize based cropping systems (Maize and maize + winter herbage);
2. Winter cereals + summer herbage;
3. Permanent and temporary grasslands.

4.1.1 Maize based cropping systems

Introduction

Maize is the main crop in Northern Italy, covering more than 20% of the arable land. It is widely cultivated both in stockless or stocking farms, where it represents from 38% to 72% of the land use. Most of animal husbandry (any breed) relies strongly on maize for feeding. In stockless farms it is cultivated for food, for feed and for industrial utilisation. No-food utilisation of maize, for industrial and energy productions, has been recently of increasing importance. In the five regions involved in this derogation request, more than 90% of the Italian maize is produced. Italy also imports maize.

Maize is used for grain production (eventually harvesting the straw for animal bedding) or for silage production (whole plant harvested for animal feeding). Hybrids used for both types of productions are, in general, late or very late maturing types, mainly FAO 600 and 700. These hybrids types represent the majority of the Italian maize seeds sales, 35.7% and 30.4%, respectively (*Table 16*) (Pioneer Hi-Bred Italia, personal communication, 2008). In the details, FAO 600 and 700 hybrids count for 38,1% and 16,8 % of grain market, while they rise till 29,9% and 63,7%, respectively, in the animal direct feeding market (Silage + High Moisture Maize Grain).

Fao Classes	**Maize for grain market**	**Maize for silage + HMCG* market** %	**Total market of maize**
300	9.0	0.0	6.4
400	11.2	1.5	8.4
500	24.6	4.9	18.9
600	38.1	29.9	35.7
700	16.8	63.7	30.4
Total	100.0	100.0	100.0

Table 16 - Maize hybrids market in Italy for maize for grain, maize for silage + High Moisture Maize Grain (HMCG) and for the total market of maize (Source: Pioneer Hi-Bred Italia, personal communication, 2008).

Maize class FAO 600-700 is planted mid March-beginning of April. Its growing cycle is 145-150 days in the climatic conditions of Northern Italy, where 1500-1600 Growing Degree Days are available and sufficient to achieve physiologic ripening.

In dairy farms maize is also cultivated in combination with Italian ryegrass (double annual crops). In this case only medium-late or early (FAO 400-500) maturing maize hybrids are used and harvested for silage production. Maize growing season is about one month shorter. Early maturing hybrids (FAO 300 or 400) are seldom used: they are grown only when maize is sown in early summer after barley or wheat harvest (in June or early July).

Agricultural management of medium, late and very late maturing maize

Figure 34 shows current practices adopted in the cultivation of medium, late and very late maturing maize.

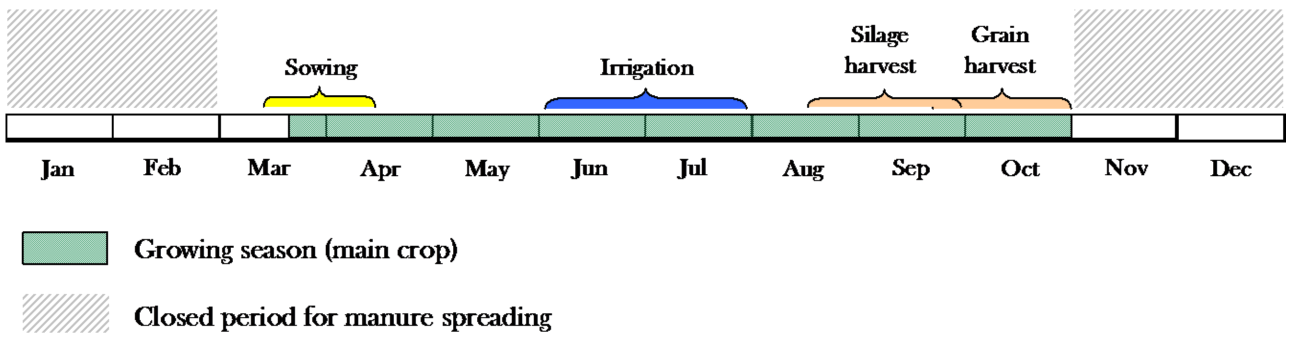


Figure 34 - Current practices adopted in the cultivation of medium, late and very late maturing maize.

Ploughing is performed in autumn in heavy soils, in spring or autumn in other soil types. Animal manures are usually spread before soil tillage and incorporated into the soil with ploughing.

Maize is sown earlier in sandy soil than in heavy soil, and in the warmer Eastern part of the Po Plain than in the higher more continental Western part. Despite these differences maize yield tends to level off everywhere, as yield is more influenced by soil fertility and availability of water than by other factors.

In general, late maturing maize is sown from mid March to mid April. The maize harvest for silage production starts from mid of August and lasts until the end of September, while in the case of maize for grain harvest starts in September and continues till the end of October. According to usual farming practices, mineral fertiliser distribution takes place just before or in combination with sowing (NPK fertiliser) and as top dressing (N). Typical farm practices in breeding farms where manure is available provide around 100 kg N ha^{-1} as mineral fertilisers. Farms relying strongly on manure fertilisation tend to skip any mineral N and P fertilisation before sowing. Therefore the total or the largest part of mineral N is provided to maize as top dressing.

In Northern Italy, maize production is usually high. When water is not a limiting factor, grain production of FAO 600 and 700 hybrids range from 12 to 14 t DM ha^{-1} (*Table 17*) and the whole above-ground plant production from 21 to 25 t DM ha^{-1}. The average production of 12.6 (only grain) and 22.9 (whole plant) t DM ha^{-1} correspond to 192 and 266 kg ha^{-1} of N uptake. For this production level, the average amount of P_2O_5 and K_2O removed from the whole plant is 110 and 275 kg ha^{-1}, respectively (Grignani et al. 2003). Therefore, the average value of N/ P_2O_5 ratio is 2.4.

a)

Crop			FAO class	Plant part	Number of measurements	Yield (DM t ha^{-1})			
						Average	1st quartile	median	3rd quartile
Maize	only grain	irrigated	(FAO 200-300)	grain	*926*	10.5	9.5	10.7	11.7
			(FAO 400-500)		*10979*	12.0	11	12.2	13.2
			(FAO 600-700)		*22330*	12.6	11.6	12.7	13.7
		not irrigated	(FAO 200-300)	grain	*1072*	8.9	7.8	9	10.1
			(FAO 400-500)		*5238*	10.0	8.8	10.1	11.4
			(FAO 600-700)		*4428*	10.7	9.5	11	12.2
Maize	whole above ground plant	irrigated	(FAO 400-500)	total	*82*	22.1	20.4	22.1	23.6
			(FAO 600-700)		*1478*	22.9	20.7	23	25.1
		not irrigated	(FAO 400-500)	total	*11*	18.9	18.1	20.1	20.7
			(FAO 600-700)		*163*	20.0	17.5	20.5	22.6

b)

Crop			FAO class	Plant part	Number of measurements	N Uptake (kg ha^{-1})			
						Average	1st quartile	median	3rd quartile
Maize	only grain	irrigated	(FAO 200-300)	grain	*45*	156	141	159	174
			(FAO 400-500)		*246*	172	157	175	189
			(FAO 600-700)		*191*	192	177	193	209
		not irrigated	(FAO 200-300)	grain	*45*	132	116	134	150
			(FAO 400-500)		*246*	143	126	145	163
			(FAO 600-700)		*191*	163	145	167	186
Maize	whole above ground plant	irrigated	(FAO 400-500)	total	*65*	254	234	254	271
			(FAO 600-700)		*1007*	266	241	267	292
		not irrigated	(FAO 400-500)	total	*11*	217	208	230	237
			(FAO 600-700)		*163*	243	212	249	274

Table 17 - Average yield (a) and N uptake (b) for the main types of maize in the Italian northern plain (Source: Pioneer Hi-Bred Italia, modified by AGROSELVITER University of Turin. Reference years: 2004-2008).

Agricultural management of medium-late or early maturing maize in combination with a winter herbage

When maize is cultivated in combination with a winter herbage (e.g., Italian ryegrass, *Lolium multiflorum* Lam.), it is planted in May, after Italian ryegrass harvest. When maize is cultivated after a winter cereal herbage, especially barley, it is planted at the end of May or in early June when the winter cereal is harvested (normally for silage production). In all instances, winter herbage and maize are harvested in the same year, and the total amount of aboveground N content of both crops is removed from the field.

Figure 35 shows current practices adopted for this type of cropping system. After the winter herbage harvest, manure can be spread and soil is usually tilled. Irrigation and top dressing fertilisation of the maize crop are similar to those of the longer maturing maize. Maize is harvested at the end of September or at the beginning of October. The winter herbage is sown soon after harvest of silage maize. The field is tilled with a disk harrowing or is ploughed. Usually the winter herbage also receives manure before autumn soil tillage. The winter crop is harvested from mid-May to the end of May.

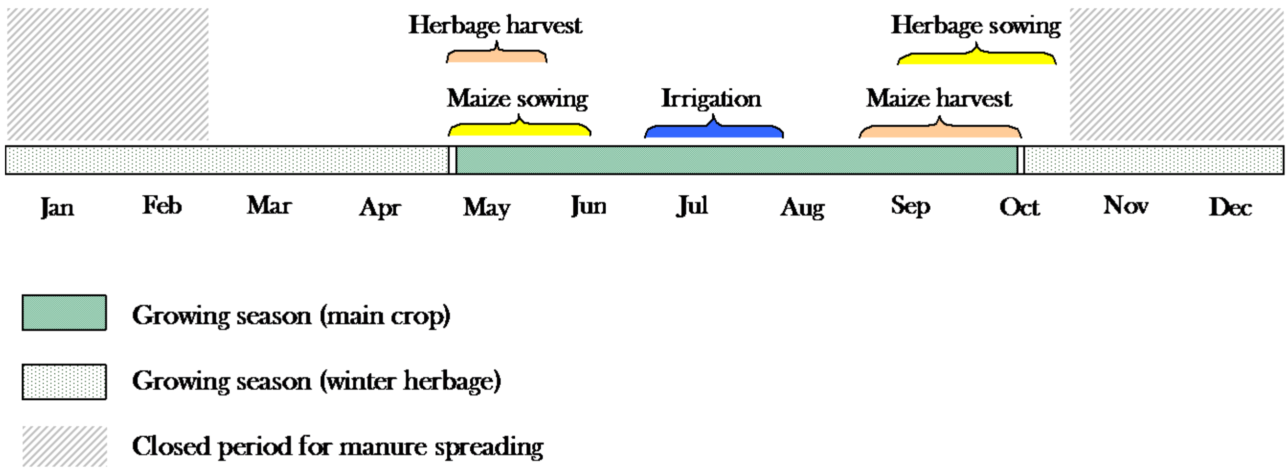


Figure 35- Current practices adopted in the cultivation of maize in combination with Italian ryegrass (double annual crops)

In this system maize production and N uptake are lower than those referred to the longer cycle. In particular, maize uptake are approximately 216-240 kg N ha^{-1} with a production of about 18-20 t ha^{-1} of total DM. Italian ryegrass production are about 5-7 t ha^{-1} of total D.M, with N and P_2O_5 uptake respectively of 75-105 kg ha^{-1} and 40-55 kg ha^{-1}. The double crops system is then able to produce 23-27 t DM ha^{-1}, with total N and P_2O_5 uptake of 290-340 kg ha^{-1} and 130-155 kg ha^{-1} Therefore, the average value of N/ P_2O_5 ratio is about 2.2.

Scientific elements supporting the request of exceeding 170 kg N ha^{-1} year^{-1} from animal manure for maize and maize-based forage systems;

The following section provides scientific elements based on literature, supporting the request of exceeding 170 kg N/ha/year from animal manure, when maize or double annual crops (maize in combination with a winter herbage) are cultivated. The reported scientific elements are based on research studies carried out in Northern Italy plain at field, farm and regional scale.

a) Field scale studies

- Nitrogen uptakes and nitrogen balances of maize

1) A long-term experiment was carried-out from 1993 by the University of Turin at the experimental station "Tetto Frati" in western area of the Po plain (Grignani et al., 2007; Monaco, 2005) on an alluvial deep soil. It aimed at comparing different maize-based cropping systems and manure managements. In this field experiment, cropping systems were maize for silage (Ms), maize for grain (Mg), double annual crop rotation of maize and Italian ryegrass (Mr), and a rotation maize and grass ley (Ml). The fertilisation managements were: S Low (124 kg ha^{-1} year^{-1} N from cattle slurry), S High (226 kg ha^{-1} year^{-1} N from cattle slurry), F Low (142 kg ha^{-1} year^{-1} N from farmyard manure), F High (284 kg ha^{-1} year^{-1} N from farmyard manure). All treatments also received 100 kg ha^{-1} urea-N as top-dressing. Mineral treatments received different rates of total urea-N, equal to 0, 100, 200, 300 and 400 kg ha^{-1} year^{-1}.

The experiment demonstrated the high above-ground N uptakes of maize and maize-based forage systems. Also when low N fertilisations levels are considered, maize N uptake is generally greater than 170 kg N ha^{-1} year^{-1} of N. When standard fertilisations are applied it reaches or exceeds, on average, 250 kg N ha^{-1} year^{-1}.

Table 18 shows the average aboveground N uptakes for the different cropping systems and manure-N levels. The different cropping system uptakes significantly increased when the fertilisation was moved from the "low" (124 or 142 kg N ha^{-1}) to the "high" (226 or 284 kg N ha^{-1}) level of supply of cattle slurry or farm yard manure.

Aboveground N uptakes in the unfertilised treatments show that maize is able to efficiently utilise the soil organic N released through mineralisation processes during the growing season. However, the evident decrease in soil organic matter show the need of organic fertilisers supply (Monaco et al., 2008; Bertora et al., 2009).

Comparing the response curves of N uptake at increasing amounts of mineral N with treatments receiving animal manure, it was possible to demonstrate that the Nitrogen Use efficiency (NUE) of cattle slurry and farmyard manure was on average not different from urea-N (*Figure 36*). In case of double annual crops (maize in combination with It. ryegrass), the animal manure N even showed to be more efficient than urea-N.

System	0N	S_{Low}	S_{High}	F_{Low}	F_{High}	Average
Ms	138	233	255	220	257	221 b
Mg	148	260	280	252	263	241 a
Mr	116	248	281	242	293	236 a
Average	134 c	247 b	272 a	238 b	271 a	232
Ml	202 b	240 a	261 a	254 a	261 a	243

Note: ANOVA results for Ms, Mg and Mr: system $P = 0.00$, fertilization $P = 0.00$, block $P = 0.34$, system × fertilization $P = 0.01$. ANOVA results for Ml: fertilization $P = 0.00$, block $P = 0.96$. Letters show differences for $P(F) < 0.05$.

Table 18 - Effects of fertilisation management on the above-ground N uptake of the cropping systems (kg ha-1 year-1) in the 1993–2003 period.

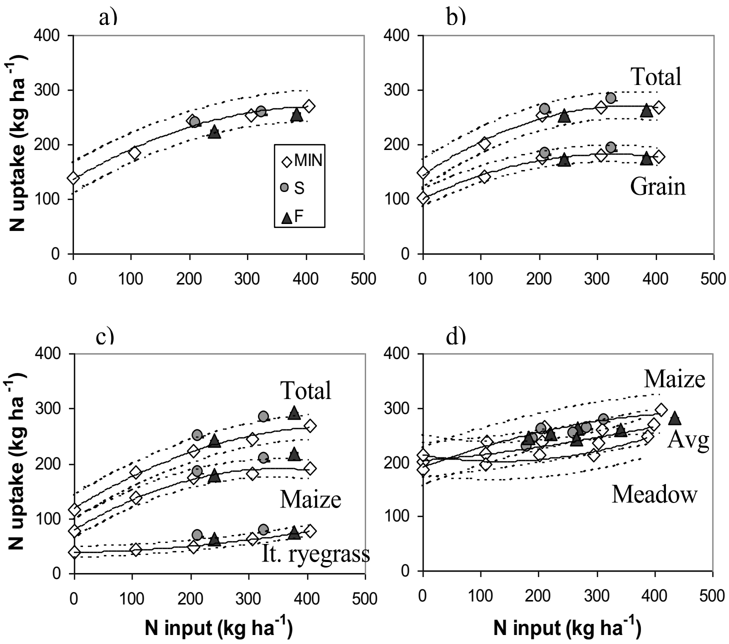


Figure 36 - Response curve of the N uptake in mineral treatments to increasing amount of N supplied.

The regression is based on the MIN treatments only, and ORG treatments are also reported in the figure. Cropping systems are Ms (a), Mg (b) and Mr (c) and MI (d). The mean annual N uptake of the total period was considered. Confidence interval of 90%.

2) In a European project, carried out in five different experimental sites in Emilia-Romagna from 2004 to 2007, total above-ground N uptakes of maize for grain fertilised with urea only or animal manure and urea were, on average, 250 kg ha^{-1} year^{-1} for the highest amount of total N supplied (233 kg/ha/year) (CRPA, Project LIFE Optima-N). Moreover, the residual amount of nitrate-N in the soil (0-75 cm layer) at the harvest was low or very low.

3) In a long-term experiment (from 1962) at the experimental station “Lucio Toniolo” of Padua University in Veneto Region, the sustainability of different crop rotations combined with different types of organic and mineral fertilisation has been studied (Giardini, 2004). In particular, the comparison of three treatments is reported in *Table 19*: maize for silage fertilised with 160 kg ha^{-1} of cattle slurry-N and 0, 70 or 140 of urea-N kg ha^{-1}. The results show that maize total aboveground biomass productions and N uptakes are high for medium and high level of fertilisation, therefore soil surface N surplus is always limited. Moreover, these treatments show a high total N efficiency, although the animal manure application to the soil has been repeated for so many years.

Cattle slurry-N	**Mineral-N**	**Total N**	**Total production**	**Total N uptake**	**Surface N surplus**	**N efficiency**
kg ha^{-1} y^{-1}			t DM ha^{-1}	kg ha^{-1} y^{-1}		%
160	0	160	17,4	152	8	0,95
160	70	230	24,4	240	-10	>1
160	140	300	24,6	231	69	0,77

Table 19 - Fertilisation levels, total production and N balance in the silage maize monoculture measured in the long-term experiment carried out by University of Padua in Veneto Region. Data refer to the 1989-2001 period.

4) In a 3 years field experiment carried out by Ersaf in a silty loam soil in an experimental farm in Lombardy, total yield and N contents of silage maize and It. Ryegrass were measured in 3 different types of cropping systems (Ersaf, 2009). Average yields of Italian ryegrass harvested in spring were equal to 6.9 t ha^{-1} $year^{-1}$ with a protein content of 13.2%. This indicates a N uptake of 146 kg ha^{-1} $year^{-1}$. Total yield of maize for silage after It. ryegrass harvest was 20.9 t DM ha^{-1} $year^{-1}$, with an aboveground N uptake of 242 kg ha^{-1} $year^{-1}$. In the same experiment a winter wheat herbage was also measured. In May, the winter wheat total biomass production was 7.1 t ha^{-1} $year^{-1}$ with a protein contents of 16.6%, that indicates N uptake of 189 kg ha^{-1} $year^{-1}$.

5) In a 6 years field experiment in Lombardy (Onofrii, 1993), a combination of maize and a winter herbage (forage) barley was cultivated in a three year experiment. Total biomass production of barley was, on average, 10.7 t DM ha^{-1} (from 9 to 13 t DM ha^{-1}). Forage maize yield was on average 17.2 t DM ha^{-1} (from 12 to 22 t DM ha^{-1}). Nitrogen uptakes, were, on average, respectively 134.4 and 161.6 kg N ha^{-1} for barley and maize. Therefore total N uptake was on average, 296 kg N ha^{-1}.

In the same experiment, the combination of winter Italian ryegrass followed by maize was studied in different rotations. Average It. ryegrass and maize yields were, respectively, 7 and 22.2 t DM ha^{-1}. Nitrogen uptakes were respectively 106 and 230 kg N ha^{-1}, with a total N uptake of 336 kg N ha^{-1}.

- *Growing season and crop N uptake dynamic*

1) *Figure 37* reports the results of maize growing season and N uptake dynamic measured in some treatments of the same trial carried out by University of Turin in Tetto Frati experimental station (Grignani et al., 2007). The results, partly published in Monaco et al. (2009), show that maize growth and N uptake for a FAO 600 hybrid could last more than 5 months.

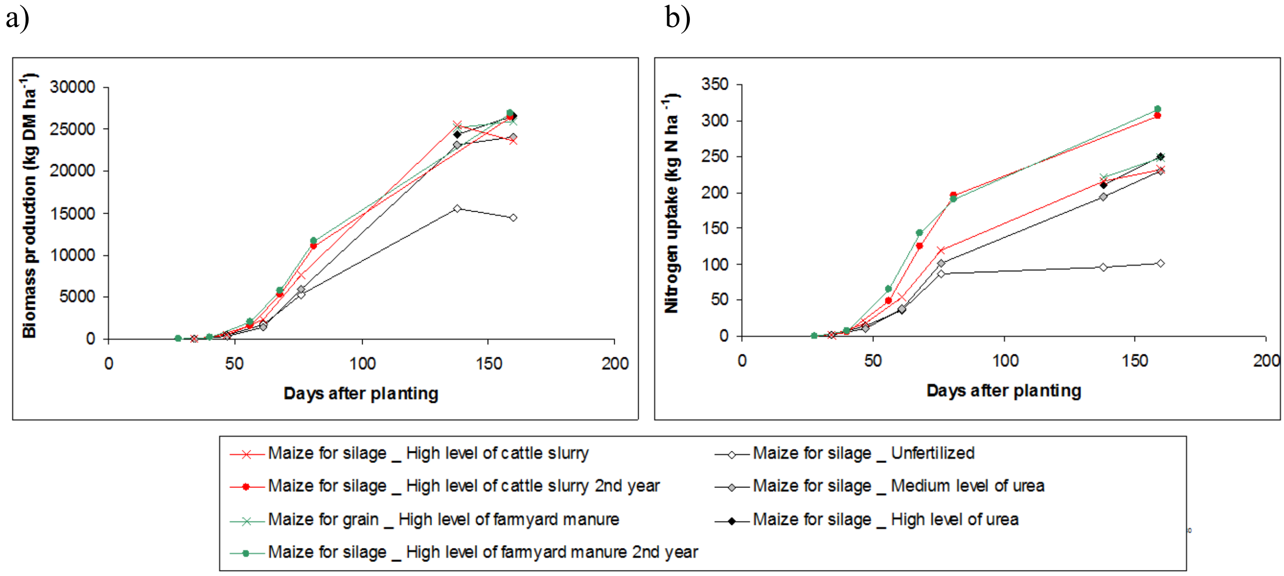


Figure 37 - Average biomass (a) and N uptake (b) of maize fertilised with different levels and types of fertilisers measured in the experimental trial of TettoFrati (Grignani et al. 2007) in 2003 and 2005. Planting dates are: 3 April 2003 and 8 April 2005.

- Soil mineral nitrogen

1) In the Tetto Frati experiment discussed above (Grignani et al., 2007), it was found that the mineral N content in soil did not increase significantly when maize fertilisation increased from the "low" (124 or 142 kg N ha^{-1}) to the "high" (226 or 284 kg N ha^{-1}) supply of cattle slurry or farm yard manure (*Figure 38*) (Grignani, unpublished data). Measurements were carried out during two different periods of monitoring (1993-1996 and 2002-2003) on a deep alluvial soil. In this figure, positive and negative values represent, respectively, a higher or lower amount of soil inorganic N in a treatment, when compared with another treatment. Four comparisons are analysed : 1) high vs low input of liquid manure-N (maize); 2) liquid manure N vs urea N (maize); 3) high vs low input of farmyard manure N (maize); 4) high vs low input of liquid manure-N (It. ryegrass and maize). In maize for silage fertilised with high amount of N, the difference is in general null or slightly positive in comparison with low level, null or slightly negative in comparison with the same amount of urea. Moreover, in the double annual crops system, treatments fertilised with cattle slurry even showed lower soil mineral N contents compared with treatments receiving a similar amount of total N provided as urea.

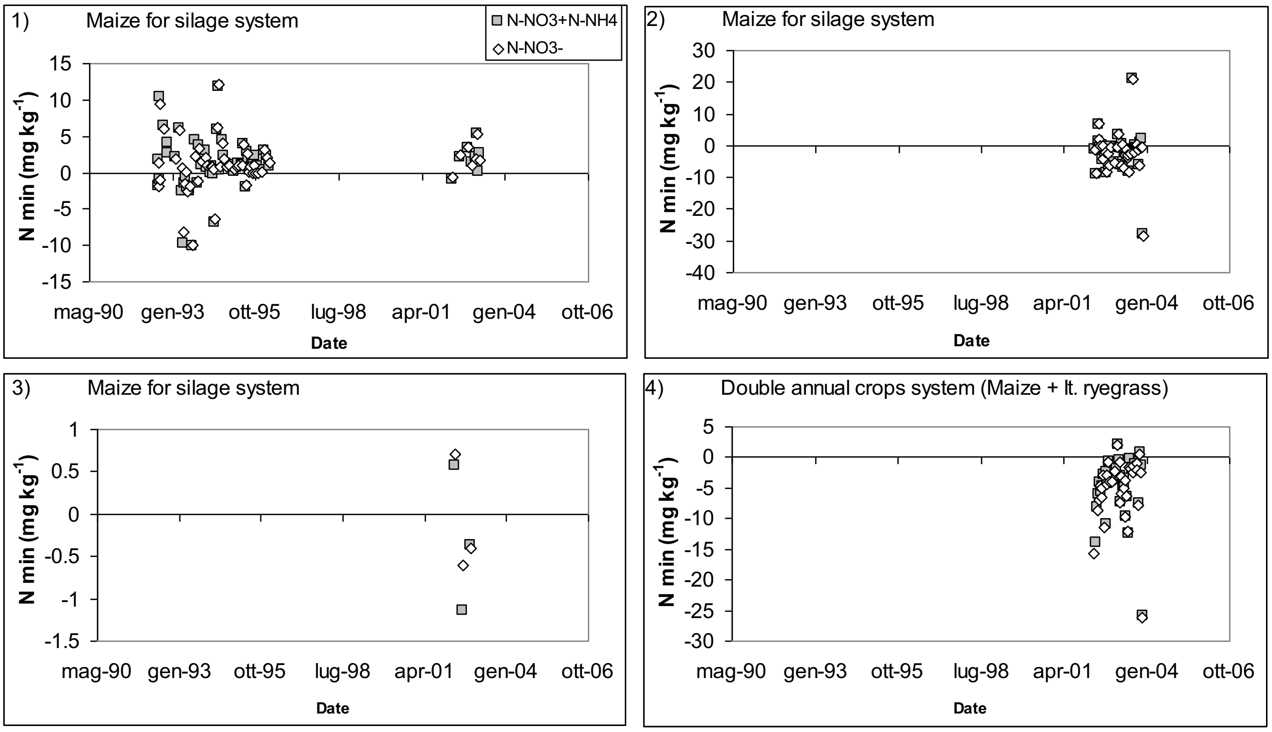


Figure 38 - Differences in soil mineral N content in the layers (50-100 cm) calculated between different agronomic managements.

Agronomic managements were: A) high level of N supplied with liquid cattle manure, B) low level of N supplied with liquid cattle manure, C) high level of N supplied with only urea, D) high level of N supplied with farmyard manure, E) low level of N supplied with farmyard manure, The differences reported in the four graphs are: 1: A-B, 2: A-C, 3: D-E and 4: A-C in the double annual cropping system

Considering only the periods without the presence of maize (from mid September to April), the differences in terms of soil inorganic N contents (*Table 20*) among the different agronomic managements demonstrated that higher level of cattle manure have null or modest consequences on the soil inorganic N contents, and that the presence of the double crops reduces soil inorganic N.

			50-100 cm	70-100 cm	50-100 cm	70-100 cm
			$N\text{-}NO_3^-$ (mg kg^{-1})		$N\text{-}NO_3^-+N\text{-}NH_4^+$ (mg kg^{-1})	
Maize for silage	Low N level	Cattle slurry	5.3*(18)*	-	6.7*(22)*	-
		Farmyard manure	1.7*(1)*	-	1.8*(1)*	-
	High N level	Urea alone	5*(9)*	10.5*(6)*	5.3*(9)*	11.3*(6)*
		Cattle slurry	5.8*(26)*	3.2*(15)*	7.2*(29)*	4.2*(15)*
		Farmyard manure	1.2*(1)*	1.4*(1)*	-	-
Double annual crops (Maize + It. ryegrass)	High N level	Cattle slurry	2.5*(9)*	2.7*(9)*	3.6*(6)*	4.7*(6)*

Table 20 - Soil mineral N content measured after maize in the winter intercropping period in different soil layersand under different fertilisation management.
Numbers in brackets refer to the numbers of measurements.

2) In a four year research study carried out by University of Padua in the Veneto plain, and funded by Regione Veneto, two different fertilisation managements of irrigated maize were compared using 1500 m^2 plots (Giardini, unpublished data). One treatment was fertilised following the Action program for NVZ, with 170 kg ha^{-1} of cattle slurry-N and 60 kg ha^{-1} of urea-N, while the other was fertilised following traditional farm practices of the area, with 340 kg ha^{-1} of cattle slurry-N and 120 kg ha^{-1} of urea-N. The crop productions and N uptakes (*Table 21*) were high for both levels of fertilisation. Although the different soil surface N balances, the two treatments showed a similar amount of N leaching, 37 and 30 kg ha^{-1} for high and low level of fertilisation, respectively.

Parameters			**High N level**	**Low N level**
Yield (DM)	Total	(t/ha)	27.9	25.9
	Grain	(t/ha)	14.2	13.7
	Stubble	(t/ha)	13.7	12.2
Rain + irrigation		(mm)	1055	1055
Etc adj		(mm)	519	508
Water drainage		(mm)	443	471
Fertilization		kg/ha	460	230
N in the above ground biomass		(kg/ha)	269	235
N surplus		(kg/ha)	191	-5
N leaching		(kg/ha)	37	30
N concentration in drainage water		(mg/l)	8.4	6.4

Table 21 - Maize production, water and N balance measured in the experiment carried out by the University of Padua in Veneto Region (average of 2007/2008).

3) An experiment was conducted for 3 years in the Veneto Plain (North East Italy) to evaluate the environmental impact of different cropping systems at different input levels (Borin et al, 1997). This experiment included a treatment with a three year cropping system (1^{st} barley and soybean, 2^{nd} silage maize, 3^{rd} Italian ryegrass and silage maize) with very high fertilisation input (in year 3, the ryegrass and maize double crop received 360 kg manure N ha^{-1} and 240 kg urea N ha^{-1}). Despite this system showed the highest leaching losses when compared with the others cropping systems (all of them receiving much lower fertilisation), the measured N concentration in the leaching water was on average only 7.9 mg N-NO_3 l^{-1}, and 10.9 mg total N l^{-1}.

b) Farm and regional scale studies

1) Data of maize production and N uptake reported in *Table 17* derived from the commercial farm network of Pioneer Hi-Bred Italia. Productivity levels and protein contents of different hybrids in different pedo-climatic and farm management conditions are measured in large field strip trials each year. Results from 44,973 field strip trials are reported for maize for grain yield in the period 2004-2008, 1,464 field strip trials for grain protein contents and 1,746 for biomass production and protein content of silage maize. Field strips are located in 35 and 23 Province of five Northern Italy Regions for grain maize and silage maize, respectively. For the most common hybrids (FAO 600 and 700) and in the case of irrigation, grain productions range (75% of samples) from 11.6 to 13.7 t DM ha^{-1} and whole plant productions from 20.7 to 25.1 t DM ha^{-1}. The level of N uptakes for the whole aboveground plant is 241-292 kg N ha^{-1}.

2) Tabacco and Borreani (2009) demonstrated the high yield and N uptakes of silage maize in a farm scale study in Piedmont. Their results were based on 183 farms. They showed that silage maize N uptakes ranged from 224 up to 314 kg N/ha depending on DM yield.

3) Bassanino et al. (2007) studied the soil surface nitrogen balances of 41 livestock farms in Northern Italy: beef breeding farms (BB), dairy cow farms (DC), suckling cow farms (SC) and pig breeding farms (PB). They found that where manure input was lower, farms tended to increase other nitrogen inputs. Most farms would be able to satisfy their crop requirements through manure N input alone. Moreover, the relationship between the soil surface crop nitrogen surplus (CBS) and the livestock stocking density was investigated (*Figure 39*). It was showed that manure N input up to 250 kg N ha^{-1}, shows the possibility of reaching low CBS. The authors concluded that a better management of crop nutrition strategies is, therefore, possible reducing mineral N input.

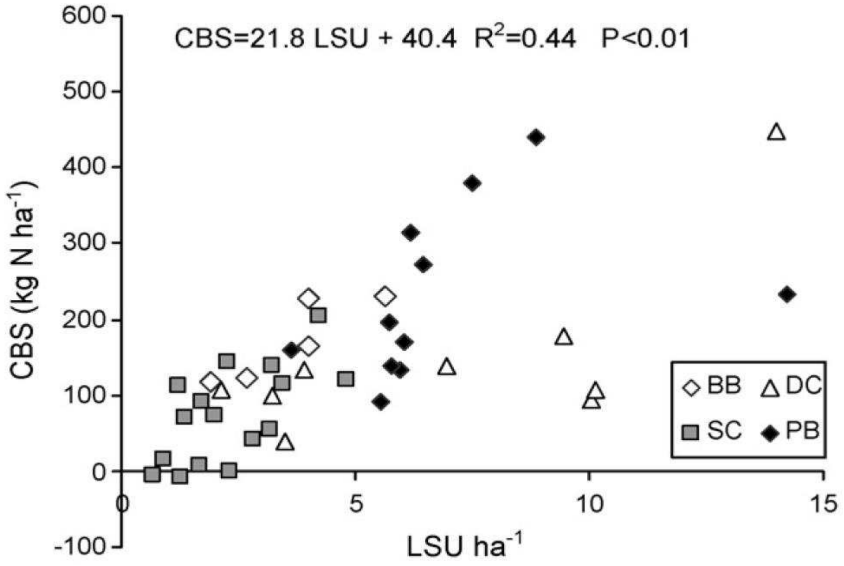


Figure 39 - Variation in the crop balance surplus (CBS, kg N/ha) as a function of animal stocking density (LSU ha-1 of total area) for each farm for four different farm types (BB: beef breeding farms; DC: dairy cow farms; SC: suckling cow farms; PB: pig breeding farms).

4) Working at a larger scale on a southern area of Piedmont, Sacco et al. (2003, 2005) found that at least 15% of the farms outside NVZ, with a high percentage of maize in the crop rotation, despite exceeding 170 kg N ha^{-1}, show a high recovery of the N supplied in organic fertiliser (above 70%). This means that a large share of maize could lead to a higher manure N recovery in the crop production, due to the high N uptake of maize crop in Italian conditions.

Conclusions

The reported technical and scientific elements allow supporting the request of exceeding 170 kg N/ha/year from animal manure in the case of maize-based forage systems of the Northern Italy plains, if some conditions are respected.

In particular, the key points are the following:

1) maize for silage, as well as maize for grain production when straw is harvested and the double annual crop systems (maize plus winter herbage) have a very high N uptake. They definitely need more than 250 kg ha^{-1} year^{-1} of total available N, supplied with organic or mineral fertilisers, provided that water is not a limiting condition;
2) in the pedo-climatic conditions of Northern Italy plains and in absence of limiting factors for crop growth, the length of biological cycle of FAO 600 and 700 hybrids generally reaches 150 days. The N uptake dynamic corresponds to the period in which soil mineralisation processes are more active;
3) increasing organic N supply and proportionally reducing mineral fertilisation allow similar or even higher N use efficiency (N uptake/N applied), mainly depending on the agronomic management adopted; this is due to the fact that the pick of maize N uptake in summer corresponds to the period of intensive soil N mineralisation;
4) the replacement of mineral fertiliser-N with manure-N can lead to similar total N surface balance in maize-based forage systems, if manure N input are limited to the 250 kg N ha^{-1} threshold.

4.1.2 Cropping systems with a winter cereal

Introduction

Winter cereals represent the second main crop in livestock farms of the Northern Italy plain, covering more than 15% of the total agricultural area. In the last years the cultivation of durum wheat has also been expanding. Winter wheat and barley are the most widespread winter cereals. They are mainly cultivated in rotation with maize or lucerne. In dairy farms they are occasionally followed by summer short cycle herbage such as, for example, maize, sorghum or *Panicum* sp. The recent increase of arable land use for energy crops cultivation has introduced a new cropping system, characterised by a winter cereal, like triticale (*Triticosecale*), harvested early for feeding anaerobic biogas digestion plant followed by a summer herbage.

Agricultural management of winter cereals

Figure 40 shows the current practices adopted in the cultivation of winter cereals.

In general, winter cereals are planted in October, till the beginning of November; they are harvested from the end of June to mid July (winter wheat) or earlier, from mid June to the end of June (barley) or triticale.

Winter cereals soils are usually ploughed just before sowing, in autumn. If animal manure is used as fertiliser, it is spread before soil tillage. The timing of manure spreading and soil tillage is influenced by the harvest date of the previous crop and by pedoclimatic conditions. If winter cereal follows another winter cereals (or the last year of a rotational ley) manure spreading and soil tillage can be anticipated to the summer. The finer is the soil structure (clay soil) and the less available is irrigation, the more frequent is this anticipation. However, stocking farms tend to cultivate summer crops or herbage. Therefore, manure spreading and soil tillage take often place in September, just prior planting.

According to usual farming practices, the large part of mineral N is provided to winter cereals as top dressing: when manure is applied in autumn, mineral fertiliser distribution takes place once or twice, at the end of the winter and at the beginning of the spring.

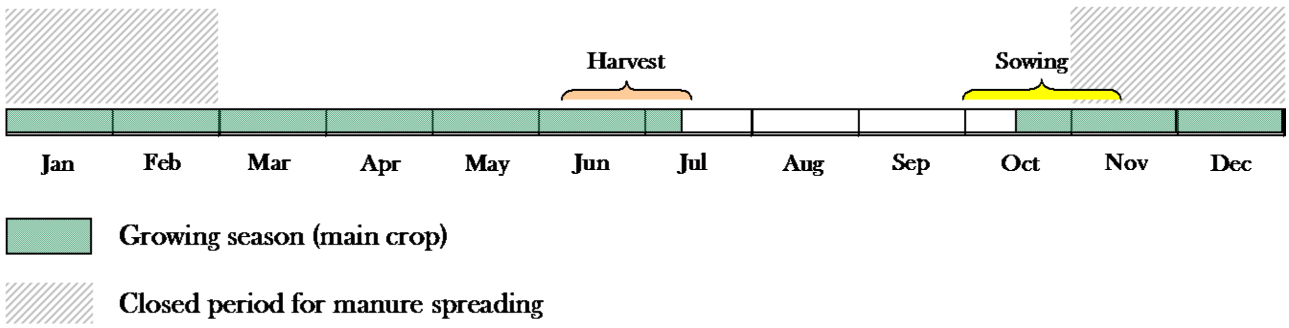


Figure 40 - Current practices adopted in the cultivation of winter cereals (e.g. winter wheat, barley)

Winter cereals straw is always harvested and either reused within the farm or sold.

In the pedo-climatic conditions of Northern Italy plain, winter cereals production levels range from 5 to 7 t DM/ha of grain both for winter wheat and barley and triticale (*Table 22*). Straw production is similar: in general, the grain/straw ratio is about 1.

Crop	Plant part	Production ($DM\ t\ ha^{-1}$)		N Uptake ($kg\ ha^{-1}$)	
		min	max	min	max
Winter cereals					
Winter wheat, barley, triticale	grain	5	7	120	160
	total	10	14	160	180
Summer herbage					
Setaria sp		4	7	96	176
Sorghum			14		212
Maize				100	140

Table 22 - Production and N uptake for winter cereals and summer herbage in the Italian northern plain (Source: AGROSELVITER Università di Torino, CRPA, CRA Lodi).

Nitrogen uptake of a winter wheat producing about 6 t DM ha^{-1} of grain, and considering 6 t DM ha^{-1} of straw also removed from the field, is about 170-180 kg N ha^{-1}. For this level of production, the level of P_2O_5 and K_2O uptake are around 70 and 120 kg ha^{-1}, respectively (Grignani et al., 2003), with a N/ P_2O_5 ratio of 2.5-2.6.

In dairy farms winter cereals can be followed by summer herbages as for example maize FAO 300-400, sorghum or *Setaria* sp. These fodder crops are usually harvested in September for silage production (maize or sorghum) or hay production (*Setaria* sp). The productivity of these summer herbages ranges between 4 and 7 t DM ha^{-1} $year^{-1}$, their uptake is generally higher than 100 kg N ha^{-1} $year^{-1}$.

The winter cereal in combination with a summer herbage is then able to produce 14-21 t DM ha^{-1} with total N and P_2O_5 uptake of about 260-300 kg ha^{-1} and 105-120 kg ha^{-1}. Therefore, the average value of N/ P_2O_5 ratio is about 2.5.

Scientific elements supporting the request of exceeding 170 kg N ha^{-1} $year^{-1}$ from animal manure for winter cereals followed by a summer herbage

The following section provides scientific elements based on literature, supporting the request of exceeding 170 kg N/ha/year from animal manure, when a winter cereal followed by a summer herbage is cultivated. The reported scientific elements are based on research studies carried out in Northern Italy plain at field scale.

- Nitrogen uptakes

1) In a field experiment carried out in Emilia-Romagna, Bortolazzo et al. (2009) reported total biomass production of winter triticale ranging from 11 to 17 t DM ha^{-1}, and N uptake from 140 to 280 kg N ha.

2) In a 1 year field experiment in Lombardy, total biomass production and N uptake for summer herbage of *Setaria italica* L. and *Pennisetum typhoides* S. at H. were measured at different sowing dates, from the beginning of June to the beginning of July (Onofrii et al, 1990). Results show the very intensive crop growing rates of all these crops from the beginning of June to the end of August. In particular, *Setaria italica* L. total aboveground biomass production ranged from 4 to 7 t DM ha^{-1} depending on planting and harvesting date and its total N uptake from 96 to 176 kg N ha^{-1}.

Pennisetum sp. total biomass was from about 4 to 8 t DM ha^{-1}, with a total N uptake from 112 to 208 kg N ha^{-1}.

3) Herbage productions and N uptakes of different hybrids of *Sorghum* sp planted after wheat harvest were measured in a 1 year field experiment in Lombardy (Tomasoni et al, 2006). Results show an average total biomass production of 12 t DM ha^{-1} (from 9.4 to 13.8 t DM ha^{-1}), while sorghum for silage shows an average production of 13.9 t DM ha^{-1} corresponding to 212 kg N ha^{-1}.

- Growing season and crop N uptake dynamic

1) *Figure 41* reports an example of winter wheat growth and nitrogen uptake measured in the experimental trial reported by Sacco et al. (2003). The results show that winter wheat growth and N uptake could last up to 250 days after crop planting, in the considered area.

a) b)

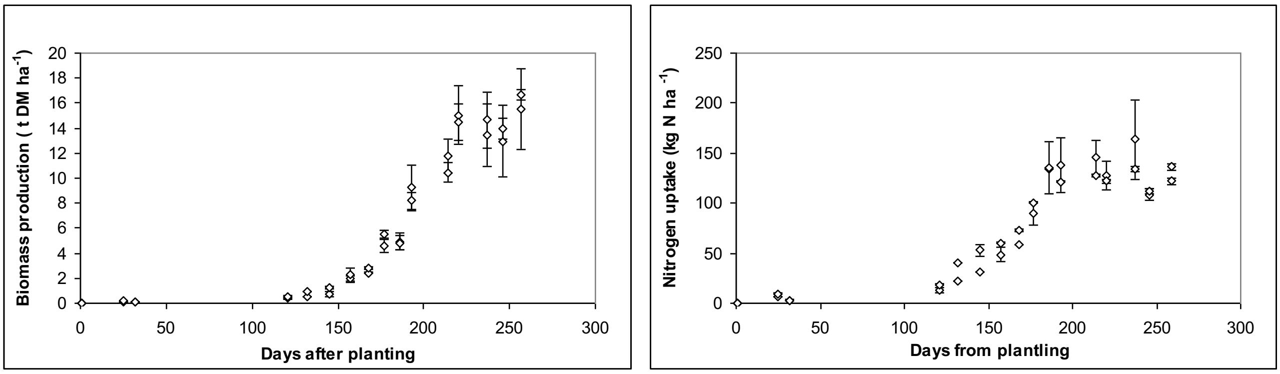


Figure 41 - Biomass (a) and N uptake (b) of winter wheat measured in the period 2001-2003 in an experimental trial reported by Sacco et al. (2003). Planting dates are: 18 October 2001 and 30 October 2002.

- Soil mineral nitrogen

1) In a 5 year experiment carried out in Piedmont on a deep coarse-loamy soil aimed at comparing different agronomic managements for cereals production, soil inorganic N was systematically measured in the soil profile (Grignani, unpublished data). Results show the nitrate-N residues at the end of the growing season (*Table 23*). These values are compatible with the potential uptake of the following summer crop.

	$N\text{-}NO_3^-$ kg ha^{-1}
07/05/1998	9
14/06/1999	39
23/06/2000	25
08/05/2001	7
20/05/2002	13

Table 23 – Average amount of soil nitrate N prior to wheat harvest in 5 different years. Date are referred to the 60-90 cm soil layer.

2) In 20 different trials in Emilia Romagna experimental farms part of the LIFE project "OptiMa-N" on nitrogen management optimisation, nitrate concentration in soil were measured after the harvest of winter wheat and barley fertilised with different rates of N, and for the same fields in autumn, just before seeding of a new crop. Immediately after the winter wheat harvest the average nitrate concentrations for the first 75 cm of soil were 14 mg/kg in 2004 and 21 mg/kg in 2005; for the same fields average concentrations increased in autumn to 44 and 52 mg/kg, respectively in 2004 and 2005. Similar results were obtained for barley, with average data of 12 mg/kg in June and 42 mg/kg in autumn. These values are compatible with the potential uptake of the following summer crop.

Conclusions

The technical and scientific elements show that the cultivation of a winter cereals for grain production, followed by summer herbage allows high N uptakes and a long growing season. Planting a summer herbage after winter cereal harvest allows for utilisation of residual N after harvest and N from soil organic matter mineralisation.

Figure 42 shows farms practices that should be adopted for the cultivation of winter cereals in the case of derogation.

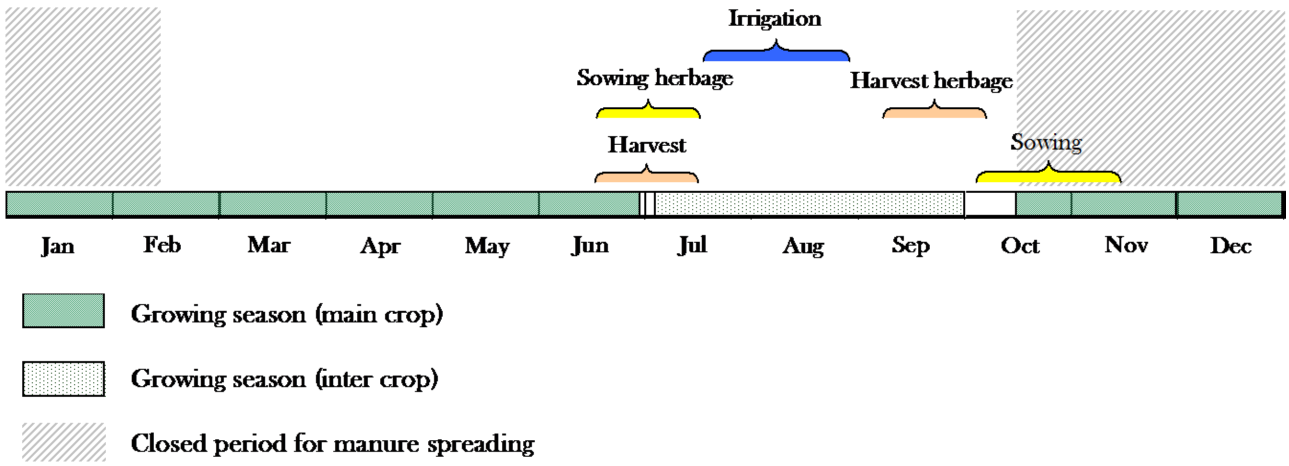


Figure 42 - Practices to be adopted for the cultivation of winter cereals in the requested derogation regime.

4.1.3 Permanent and temporary grassland

Introduction

Where maize is not a profitable crop (for example in very silty soil), when silage in not allowed (for example in Parmigiano-Reggiano farms), for rotational purposes or for a correct animal diet, permanent or temporary grassland is cultivated.

Grassland is cut four to five times per year for silage and/or hay production. Animal grazing is always rare. Both permanent and temporary grassland can be irrigated or rain fed. The share of grassland area is very variable among farm types and agro-environments. Dairy farms, especially Parmigiano-Reggiano dairy farms, but also some traditional beef breeding, use a larger share of grassland.

Temporary grasslands are generally represented by a mixture of grasses (ex. *Lolium multiflorum, Lolium perenne, Festuca arundinacea*) and legumes (ex. *Trifolium repens, Trifolium pratense, Medicago sativa*).

It must be noted that permanent grassland where legume are not seeded can show a small proportion of spontaneous legumes, mainly white clover in the summer cuts.

In some area, lucerne (*Medicago sativa* L.) represents an important fodder crop in dairy farms, but also lucerne pure stands is not considered in this document as grassland.

Agricultural management of grassland

Figure 43 shows current practices adopted in the cultivation of grasslands.

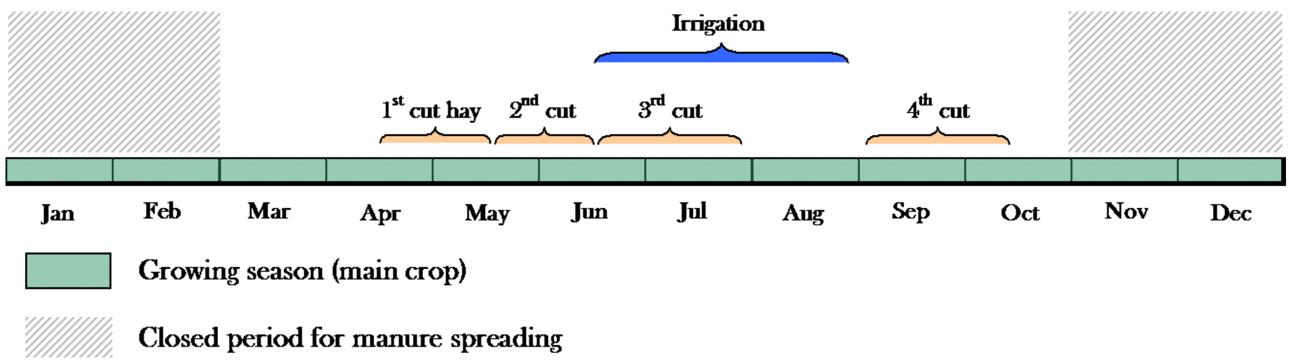


Figure 43 - Current practices adopted in the grassland management

In the pedo-climatic conditions of Northern Italy plain, irrigated grassland shows high yields ranging from 11 to 14 DM t ha^{-1} $\cdot year^{-1}$, totalised with 3-5 hay or silage cuts (*Table 24*).

Crop	Irrigation	Production (DM t ha^{-1})		N Uptake (kg ha^{-1})	
		min	max	min	max
Permanent grassland	Irrigated	11	14	280	350
	Dry	7	9	160	230
Rotational leys (grass+legume)	Irrigated	11	14	280	350

Table 24 - Production and N uptake for the main types of grassland in the Italian northern plain (Source: AGROSELVITER Università di Torino and CRPA).

Grassland uptakes are high as well. For instance, a total biomass production of 13 t DM ha^{-1} year^{-1} leads to 290-310 kg ha^{-1} of N uptake in the case of both permanent and temporary grassland (Grignani et al., 2003). For this level of production, P_2O_5 and K_2O uptake are around 110-125 and 365-390 kg ha^{-1} respectively. The average N/P_2O_5 ratio range from 2.4 to 2.7.

Scientific elements supporting the request of exceeding 170 kg N ha^{-1} year^{-1} from animal manure for permanent and temporary grassland

The reported scientific elements are based on research studies carried out in Northern Italy plain at field scale.

- *N uptakes*

1) In a on-going long-term experiment (from 1962) carried out at the experimental station "Lucio Toniolo" of Padua University (Giardini, 2004) in Veneto Region, grassland N uptakes reach, on average, 282 kg N/ha/year.

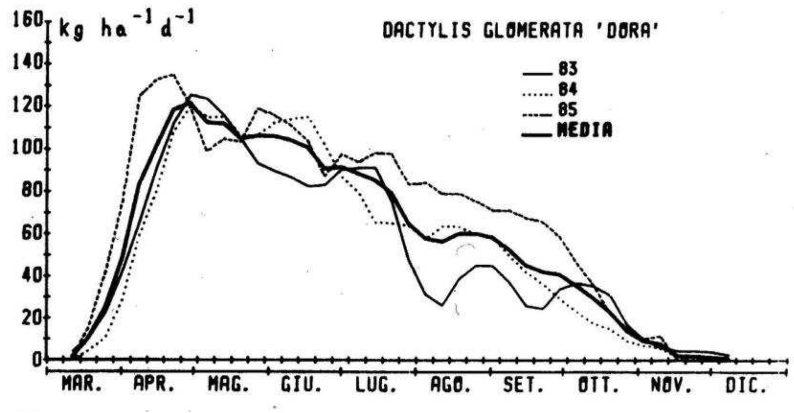
2) The results of several experiments (Grignani, 1990; Cavallero and Ciotti, 1991; Grignani, 1991; Sacco et al., 2003; Grignani et al., 2003) carried out in Piedmont showed that, in the pedoclimatic conditions of the Region, permanent and temporary grassland have in general high total N uptakes.

3) In the previous mentioned 6 year experiment in Lombardy, temporary and permanent grassland show and average production of 12.0 and 11.9 t DM ha^{-1} and 332.8 and 300.8 kg ha^{-1} of total N uptake in medium-high input treatments (Onofrii, 1993).

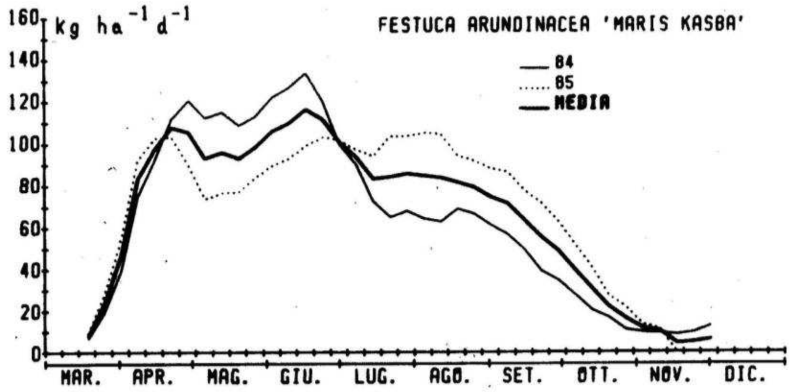
- *Growing season*

1) *Figure 44* reports growth rate seasonal curves for three forage species in irrigated grasslands, as reported by Grignani (1991). These results show the high growth rates of grassland plants in Northern Italy plain as well as the long growing season, up to 270 days per year, when water availability is not a limiting factor.

a)



b)



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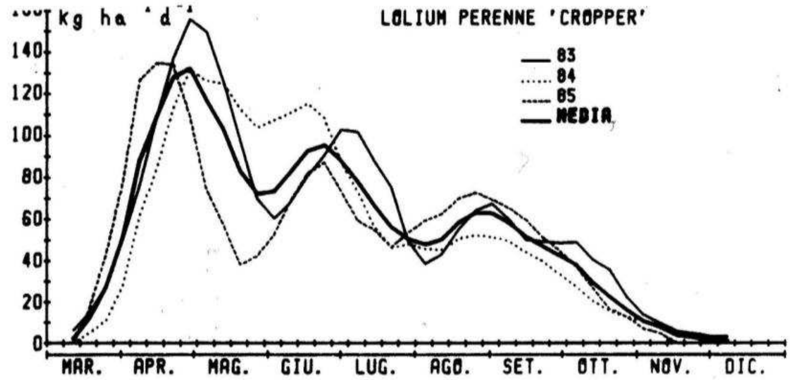

Figure 44 - Example of the period and intensity of seasonal growth for 3 different grassland species in the River Po plain (Grignani, 1991), Dactylis glomerata "Dora" variety (a), Festuca arundinacea "Maris kasba" variety (b) and Lolium perenne "Cropper" variety (c).

- Soil mineral and total nitrogen in the soil

1) In the LIFE project "OptiMa-N" trial on nitrogen management optimisation, three different swards of lucerne (*Medicago sativa* L.), tall fescue (*Festuca arundinacea* Schreb.) and a mixture of the two were grown from spring 2005 on three contiguous 30x50 m plots on highly permeable soil in the Po valley, Emilia-Romagna region (Mantovi et al., 2007 & 2008). Each plot was equipped with ceramic cup samplers to collect soil water to a maximum depth of up to 500 cm. Dairy cattle slurry was applied from 2006 to 2008 at total amounts significantly exceeding the Nitrate Directive limit (about double) on tall fescue meadow (*Festuca arundinacea* Schreb.) and close to the same limit for the mixture. Lucerne was not fertilised with nitrogen.

Soil water nitrate content was steadily low under each of the three forage crops, with average values for the tall fescue plot of 5 mg NO_3-N L^{-1} without significant negative impact on groundwater quality.

The results obtained confirm that grassland, fertilised with nitrogen from slurry applied at rates of more than 170 kg N ha^{-1} $year^{-1}$, are able to use efficiently nitrogen from manure, with very low residues in soil and no negative impact on water even in conditions of vulnerable soils.

These results confirm, also for Italian conditions, the data from the international literature demonstrating that grassland have the capability of receiving more than 170 kg N/ha/year of nitrogen from animal manure without impacting on water quality.

2) In a long term field experiment carried out by the University of Padua, variations in total N concentrations in the soil (from 1994 to 2001) were measured (*Table 25*).
With total N inputs varying from 160 to 300 kg N/ha/year (with a fixed value of 160 from cattle slurry, the rest from mineral fertilisers), total N in soil during the seven years declined by about 15-25%, showing the need for higher N inputs, especially from manure, to maintain an equilibrium in the soil N stock.

Total N input (kg/ha/year)		**Total nitrogen in soil (N %)**		
Cattle slurry	**Mineral fertilisers**	**1994**	**2001**	**Variation 1994-2001 (%)**
160	0	0.183	0.157	-14.1
160	70	0.206	0.154	-25.3
160	140	0.174	0.139	-20.3

Table 25 – N inputs from fertilisers and total N in soil measured in a 7 years trial

Conclusions

The technical and scientific elements show that the irrigated permanent and temporary grassland in the pedo-climatic condition of the Northern Italy plains is able to assure high N uptake, often higher than 300 kg N ha^{-1} $year^{-1}$ and a long period of growing season, that could allow exceeding the 170 kg N ha^{-1} $year^{-1}$ from animal manure.

4.2 Effects of derogation on N losses, results from modelling

In order to assess impact of derogation on water quality, in addition to experimental data, nitrogen losses to water from the main agricultural systems in the specific conditions of the five Northern Italy regions have been estimated through models.

ARMOSA is a model specifically developed on the basis of field trial data observed in ARMOSA project monitoring sites (Acutis et al., 2007), based on existing models. Objective of the model is to simulate water and nitrogen dynamics in the soils representative of the Po valley agricultural areas, under different climatic conditions, crops and management practices, in order to have an instrument to extend the results of field trials to larger areas and to perform scenarios analysis. Details concerning model characteristics and examples of simulations are summarised in **Annex II**.

4.2.1 Maize based cropping systems

In the context of this derogation request, as a first step, simulations have been provided using the model ARMOSA to compare the environmental performance of the following maize-based agricultural systems:

1) <u>current practices</u>

- silage maize, class FAO 700, fertilised with 170 kg N/ha/year from cattle slurry distributed half in autumn and half in spring (referred to as **Maize Cattle 170**);
- silage maize, class FAO 700, fertilised with 170 kg N/ha/year from pig slurry distributed half in autumn and half in spring (referred to as **Maize Pig 170**)

2) <u>practices under the requested derogation scheme</u>

- double annual crop rotation with maize (FAO 500) and Italian ryegrass, fertilised with 280 kg N/ha/year from cattle slurry distributed in spring (referred to as **Maize/It. Ryegrass Cattle 280**);
- silage maize, class FAO 700, fertilised with 280 kg N/ha/year from clarified pig slurry distributed in spring (referred to as **Maize Pig 280**).

Moreover, these systems have been compared under the following two different pedoclimatic conditions:

Soil 1: **Luvisol** (WRB, 2006), representative of the western part of the Po plain. Texture: sandy loam. pH: subacid-neutral. Organic carbon content (upper 30 cm): 1,2%.
Rainfall: 1095 mm/year.

Soil 2: **Calcisol** (WRB, 2006), representative of the eastern part of the Po plain. Texture: clay loam. pH: subalkaline. Organic carbon content (upper 30 cm): 1,4%
Rainfall: 698 mm/year.

Results of modelling are summarised in the following tables.

	N Input[1] Kg N/ha	Yield[2] DM t/ha	N Uptake[2] Kg N/ha	Leaching Kg N/ha	mm water	$mg/l\ NO_3$
Current practices						
Maize Cattle 170 (Soil 1)	360	22.8	254	64	785	36
Maize Cattle 170 (Soil 2)	360	22.0	281	50	440	51
Under requested derogation						
Maize/It. Ryegrass Cattle 280[3] (Soil 1)	360	19.6 5.7	225 69	3	681	2
Maize/It. Ryegrass Cattle 280[3] (Soil 2)	360	17.4 6.9	211 91	3	293	4

(1) Manure N + N from chemical fertilisers
(2) total aboveground biomass
(3) where two data are in the same cell, the first is referred to maize, the second to Italian ryegrass

Table 26 – Average annual values for different parameters, simulations for maize cattle systems.

Comparing **Maize Cattle 170** vs. **Maize/It. Ryegrass Cattle 280 (***Table 26***)**, results show that, for both soils, DM yields and N uptake are significantly increased in the derogation scenario. In the system under the requested derogation scheme, N efficiency is higher and the N leaching is significantly reduced.

	N Input[1] Kg N/ha	Yield[2] DM t/ha	N Uptake[2] Kg N/ha	Leaching Kg N/ha	mm water	$mg/l\ NO_3$
Current practices						
Maize Pig 170 (Soil 1)	360	22.9	264	75	785	42
Maize Pig 170 (Soil 2)	360	22.1	289	62	440	62
Under requested derogation						
Maize Pig 280 (Soil 1)	355	22.9	265	38	785	21
Maize Pig 280 (Soil 2)	355	22.1	279	30	440	30

(1) Manure N + N from chemical fertilisers
(2) total aboveground biomass

Table 27 – Average annual values for different parameters, simulations for maize pig systems.

Also comparing **Maize Pig 170** vs. **Maize Pig 280 (***Table 27***)**, results show that, although DM yields and N uptake are quite similar, in the system under the requested derogation scheme the N leaching is significantly reduced.

Different soil and climate characteristics lead to a water percolation about two times higher in the soil 1 (Luvisol) than in the soil 2 (Calcisol). This influences the relative nitrate concentrations, higher in leaching water from Calcisol than from Luvisol.

4.2.2 Cropping systems with a winter cereal

As a second step, environmental performance of the following agricultural systems characterised by the presence of winter cereal have been derived using the same model, under the same pedoclimatic conditions:

1) current practices

- winter wheat (for 3 consecutive years) + silage maize, class FAO 700 (for the succeeding 2 years, to interrupt wheat monocolture), fertilised with 170 kg N/ha/year from cattle slurry distributed in autumn on winter wheat, half in autumn and half in spring on maize (referred to as **Wheat+Maize Cattle 170**);

2) practices under the requested derogation scheme

- double annual crop rotation with winter wheat and *Panicum* (for 3 consecutive years) + silage maize, class FAO 700 (for the succeeding 2 years), fertilised with 250 kg N/ha/year from cattle slurry distributed in autumn on winter wheat, in summer on *Panicum*, in spring on maize (referred to as **Wheat/*Panicum*+Maize Cattle 250**).

Results of modelling are summarised in the following table.

	N Input[1] Kg N/ha	Yield[2] DM t/ha	N Uptake[2] Kg N/ha	Average annual leaching Kg N/ha	mm water	mg/l NO_3
Current practices						
Wheat+Maize Cattle 170[3] (Soil 1)	257	13.5 22.5	144 262	42	675	27
Wheat+Maize Cattle 170[3] (Soil 2)	257	12.7 21.9	149 296	39	261	66
Under requested derogation						
Wheat/*Panicum*+Maize Cattle 250[4] (Soil 1)	337	14.0 5.5 23.0	149 110 268	9	687	6
Wheat/*Panicum*+Maize Cattle 250[4] (Soil 2)	337	13.4 4.7 22.0	152 103 294	7	352	9

(1) Manure N + N from chemical fertilisers
(2) total aboveground biomass
(3) where two data are in the same cell, the first is referred to wheat, the second to maize cultivated the following year
(4) where three data are in the same cell, the first is referred to wheat, the second to *Panicum* cultivated the same year, the third to maize cultivated the following year

Table 28 – Average annual values for different parameters, simulations on systems based on winter wheat.

Comparing **Wheat+Maize Cattle 170** vs. **Wheat/*Panicum*+Maize Cattle 250** (*Table 28*), results show that, for both soils, DM yields and N uptake are increased in the derogation scenario, due to the summer herbage cultivation. In the system under the requested derogation scheme the N leaching is still lower than in rotations with winter wheat in non derogation conditions.

Also in this case, different soil and climate characteristics lead to a water percolation about two times higher in the soil 1 (Luvisol) than in the soil 2 (Calcisol). This influences the relative nitrate concentrations, higher in leaching water from Calcisol than from Luvisol.

The whole N efficiency (ratio between N uptake and total N input) provided by the model simulation results is around 75% for both "current" and "requested derogation" practices. If we assume a mineral N efficiency of 100%, we will get an efficiency of the organic N of about 48% for "current practices" and 60% for "derogation practices". Those figures almost fit the standards provided by the current Action Programmes (the first one) and proposed in the derogation request (the second one), where only application of manure at high efficiency is allowed.

Concerning possible effects of the derogation on surface runoff to surface waters and on surface water quality (including eutrophication) the simulation with ARMOSA model show that:

1) total N input in conditions described in *Table 26* and *Table 27*, is approximately the same in derogation and in non derogation conditions. What changes is the proportion between N from manure and N from chemical fertilisers. N uptake is also similar (or lower) in non derogation and in derogation conditions. Therefore, is not foreseen that derogation would increase N release to surface water and worsen trophic conditions compared to non derogation conditions.

2) in the rotation described in *Table 28* N input in derogation conditions exceeds approximately 60 kg N/ha input in non derogation case. However, in derogation farms, a second crop ensuring soil cover after wheat is sowed; this crop would have an N uptake of approximately 60 kg N/ha and would use the possible residual mineral N in soil after wheat cropping. Also in this case, increased losses through subsurface runoff and surface runoff are not likely.

5. Farms and area potentially encompassed by derogation

In *Table 29* below, a rough estimate of the number of farms and crop area potentially encompassed by the derogation is provided.

Farm type	Farms candidate to derogation			Agricultural area candidate to derogation		
	n.	**n. of total farms in NVZ + non VZ**	**% of total**	**ha**	**Total area (NVZ + nonVZ) (ha)**	**% of total area (NVZ + nonVZ)**
Total 5 Regions						
Cattle farms	10343	65495	**15.8**	300000	4131000	**9.7**
Pig farms	1070	13422	**7.9**	101000		

Table 29 – Potential farms and area involved for derogation (SIN elaboration from RRN data, with reference to National Data Bank on livestock).

Concerning cattle, Lombardy and Veneto have the larger number of farms and hectares with higher potential number of derogation requests.

For pigs, Lombardy reaches the maximum number of farms and hectares, followed by Piedmont.

Emilia-Romagna and Friuli Venezia Giulia have the lowest percentages but livestock refers to very specialised agricultural areas: Parmigiano-Reggiano cheese, Parma ham, San Daniele ham.

6. Monitoring and control

6.1 On farm measures

1) A **fertilisation plan** will be kept for each farm, for its whole acreage, describing the crop rotation and planned application of manure and nitrogen and phosphate fertilisers.

Plans will be revised no later than ten days following any change in agricultural practices to ensure consistency between plans and actual agricultural practices.

A fertilisation account describing the actual fertilisation practices will be kept in each farm

Each farm benefiting from an individual derogation will accept that the fertilisation plan and the fertilisation account can be subject to control.

2) **Nitrogen and phosphorous analysis in soil** will be performed at least once every 4 years and 5 hectares, for the whole farm surface.

3) A **minimum set of analysis** (DM, total N and P, TOC) will be performed **on solid fraction** samples taken from each single stored stock to be exported. The results of the analysis will be communicated to the receiving farmer.

6.2 Authorities' monitoring activities

1) **Maps or tables showing data** concerning the percentage of farms, number of parcels, percentage of livestock and percentage of agricultural land covered by individual derogation for each Municipality will be drawn by the competent authority and will be updated every year.
2) The existing **monitoring network for sampling of surface and groundwater** will be maintained and, if necessary, integrated to assess the impact of the derogation on water quality.
3) **Survey and nutrient analysis** derived from the on farm monitoring activities will provide data on local land use, crop rotations and agricultural practices on farms benefiting from individual derogations.
4) **Monitoring sites** will be established assessing N cycle and quantifying N and P losses to surface and groundwater: at least 15 sites representative of conditions of derogation farms. These results will also be used to calculate through models N losses due to the application of the derogation scheme.

6.3 Authorities' control activities

1) The competent authorities will carry out **administrative controls** in respect of all farms benefiting from an individual derogation for the assessment of compliance with the maximum amount of nitrogen per hectare per year from livestock manure, with nitrogen and phosphorus maximum fertilisation rates, conditions on land use and on manure treatment and transport.
2) The competent authorities will ensure **on-spot controls of manure transport** operations, on at least 1% of transported stocks. Controls will include, at least, verification of the fulfilment of the obligations on accreditation, assessment of accompanying documents, verification of manure origin and destination (GPS tracking) and sampling of transported manure.
3) A programme of **field inspections** will be established. The field inspections will cover at least 3% of the farms benefiting from an individual derogation on farm basis and at least 5% of the

farms benefiting from an individual derogation on parcel basis. Controls on the derogated fields will be carried out by the competent Authorities within each region.

7. Final considerations

Derogation in the regions of Northern Italy is in line with the achievement of the Nitrates Directive objectives, as it does not increase nutrient losses, while allowing utilisation of a higher proportion of nitrogen from manure for fertilisation practices.

Improvement of agricultural practices required to farmers in order to benefit from derogation could help the achievement of the Directive objectives.

Derogation is a driver which promotes:

- higher manure N efficiency in derogation farms;
- export of organic matter from NVZ to soils with low OM content, with positive effects on soil structure (i.e. through export of solid separated fractions);
- manure quality (processing of solid fractions for stabilisation and energy recovery);
- reinforcement of monitoring and controls.

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Annex I - Reference to the regional Acts implementing the Action Programmes

Piedmont

Decreto Presidente Giunta Regionale n. 10/R del 29 ottobre 2007

Regolamento regionale recante 'Disciplina generale dell'utilizzazione agronomica degli effluenti zootecnici e delle acque reflue e programma di azione per le zone vulnerabili da nitrati di origine agricola (legge regionale 29 dicembre 2000, n. 61)' (TESTO COORDINATO)

Lombardy

Deliberazione della Giunta regionale n. 8/3439 del 7 novembre 2006

Adeguamento del Programma d'azione della Regione Lombardia di cui alla d.g.r. n. 17149/96 per la tutela e risanamento delle acque dall'inquinamento causato da nitrati di origine agricola per le aziende localizzate in zona vulnerabile, ai sensi del d.lgs. n. 152 del 3 aprile 2006, art. 92 e del D.M. n. 209 del 7 aprile 2006.

Veneto

Deliberazione della Giunta regionale n. 2495 del 7 agosto 2006

Recepimento regionale del DM 7 aprile 2006. Programma d'azione per le zone vulnerabili ai nitrati di origine agricola del Veneto

Friuli Venezia Giulia

Decreto del Presidente della Regione 27 ottobre 2008, n. 0295/Pres

Approvazione del Programma d'azione della Regione Friuli Venezia Giulia per la tutela ed il risanamento delle acque dall'inquinamento causato da nitrati di origine agricola per le aziende localizzate in zone vulnerabili, ai sensi del decreto legislativo n. 152 del 3 aprile 2006, e del decreto ministeriale del 7 aprile 2006.

Emilia-Romagna

Deliberazione della Giunta regionale progr. n. 96 del 16 gennaio 2007

Attuazione del decreto del Ministro delle politiche agricole e forestali 7 aprile 2006. Programma d'azione per le zone vulnerabili ai nitrati da fonte agricola - Criteri e norme tecniche generali.