UNDP/GEF Danube Regional Project

Policies for the Control of Agricultural Point and Non-point Sources of Pollution & Pilot Projects on Agricultural Pollution Reduction (Project Outputs 1.2 and 1.3)

Inventory of Mineral Fertiliser Use in the Danube River Basin Countries with Reference to Manure and Land Management Practices

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Final Report

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”Policies for the control of agricultural point and non-point sources of pollution”
and “Pilot project on agricultural pollution reduction”
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Preface

The UNDP-GEF Danube Regional Project supports through this Project Component the development of policies for the control of agricultural point and non-point sources of pollution and the conceptualization and implementation of pilot projects on agricultural pollution reduction in line with the requirements of the EU Water Framework Directive.

The Overall Objective of the Danube Regional Project is to complement the activities of the ICPDR required to strengthen a regional approach for solving transboundary problems in water management and pollution reduction. This includes the development of policies and legal and institutional instruments for the agricultural sector to assure reduction of nutrients and harmful substances with particular attention to the use of fertilizers and pesticides.

Following the mandate of the Project Document,

Objective 1 stipulates the "Creation of Sustainable Ecological Conditions for Land Use and Water Management" and under

Output 1.2, "Reduction of nutrients and other harmful substances from agricultural point and non-point sources of pollution through agricultural policy changes",

Activity: 1.2-3 requires to "Review inventory on important agrochemicals (nutrients, etc) in terms of quantities of utilization, their misuse in application, their environmental impacts and potential for reduction"

The present document "Inventory of Mineral Fertiliser Use in the Danube River Basin Countries with Reference to Manure and Land Management Practices" responds to this mandate in providing an analysis on the present use of mineral fertiliser, the existing mechanisms of regulation and control and proposed measures for policy reforms and their practical application in line with the requirements of the EU Directives and regulations.

The result of this study on the use of mineral fertilisers (including reference to manure and land management practices) complements the review and analysis presented in the other key documents produced within the framework of Output 1.2:

- *Inventory of Agricultural Pesticide Use in the Danube River Basin Countries*
- *Inventory of Policies for Control of Water Pollution by Agriculture in the Danube River Basin Countries*
- *Draft Concept for Best Agricultural Practice for the Danube River Basin Countries*

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Abbreviations and Acronyms

BAP	Best Agricultural Practice
CAP	Common Agricultural Policy
DRB	Danube River Basin
DRP	Danube Regional Project
EC	European Commission
EU	European Union
FAO	UN Food and Agriculture Organisation
FAOSTAT	Statistical database of the UN Food and Agriculture Organisation
GEF	Global Environmental Facility
ICPDR	International Commission for the Protection of the Danube River
K	Potassium
Kg/ha	Kilogrammes per hectare
MONERIS	Modelling Nutrient Emissions in River Systems
UNDP	United Nations Development Programme
N	Nitrogen
P	Phosphorus
WFD	Water Framework Directive

Country Codes Used

BG	Bulgaria
BH	Bosnia and Herzegovina – consisting of 2 entities: FedBH – Federation of Bosnia and Herzegovina RS – Republic of Srpska
CZ	Czech Republic
HR	Croatia
HU	Hungary
MD	Moldova
RO	Romania
SK	Slovakia
SL	Slovenia
UA	Ukraine
CS	Serbia and Montenegro (previously the Former Republic of Yugoslavia)

Executive Summary

Introduction

Modern agricultural production systems have developed by making widespread use of mineral fertilisers to replace the traditional reliance upon crop rotations and animal manures to maintain and enhance soil fertility and support profitable crop production. The two most important plant nutrients applied as mineral fertilisers are nitrogen (N) and phosphorus (P). Both occur naturally in the soil and are essential for crop growth.

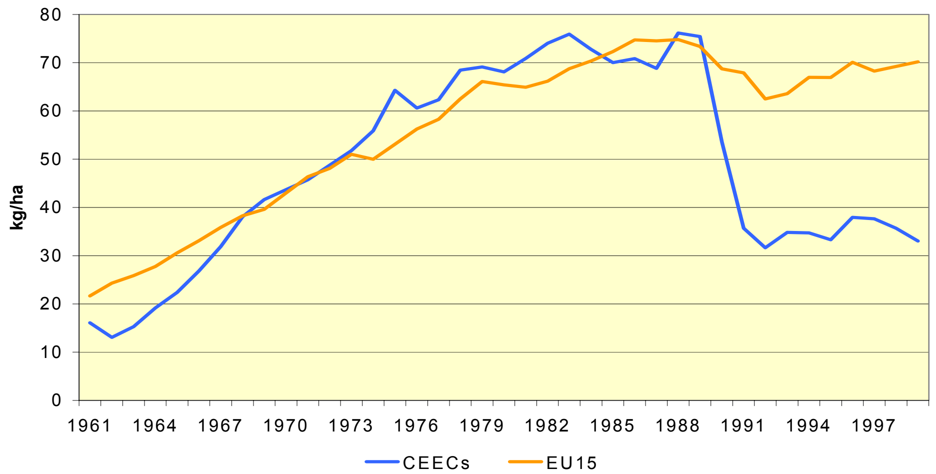
The collapse of the centrally-planned economies of central and eastern Europe in the early 1990s caused a social and economic crisis that profoundly affected agriculture in the central and lower Danube River Basin (DRB). These changes inevitably led to a significant reduction in agricultural productivity in the region, including a decline in the use of external inputs such as mineral fertilisers.

Reliable data on mineral fertiliser use in the central and lower DRB region are not available for the decades leading up to 1990. However, the limited data available from the FAOSTAT database shows that after rising strongly for three decades the use of N fertilisers (kg N/ha) by farmers in the former communist DRB countries dropped by approximately 50% around the year 1990 and is now far below the EU average (Figure 1). The decline in fertiliser use was more severe in some countries than others – in Bulgaria, the average application rate of fertiliser N fell from 109.9 kg N/ha in 1981 to 29.9 kg N/ha in 1999.

However in all countries, the reduction in the use of mineral fertilisers was the result of economic necessity rather than environmental awareness since for most farmers the lack of working capital has made it difficult to buy in more than the minimum of farm inputs.

At the same time, significant changes also occurred in livestock production. The de-collectivisation and privatisation of the state-controlled animal breeding complexes was particularly dramatic in many DRB countries and led to a significant decline in livestock numbers by approximately 50% in most countries, as well as a major change in the way that farm animals are kept. With the decline in livestock numbers there has also been a decline in the availability of manure as a traditional source of crop nutrients and this has resulted in a decline in the nutrient balance of many agricultural soils in the DRB countries to the point that farmers are now relying upon the fertility reserves of the soil to maintain their relatively low levels of crop yield.

Figure 1: Long-term trends in nitrogen fertiliser use (kg N/ha) in selected central and lower DRB countries and EU Member States[1]



[1] Due to limited data availability, the description of the trend in N fertiliser consumption is limited to the following DRB countries: Bulgaria, Czech Republic, Hungary, Romania and Slovakia

Source: FAOSTAT - database of the UN Food and Agriculture Organization.

The aim of this report is to develop an inventory of fertiliser market products for the central and lower DRB on a country-by-country basis and to review their typical use, misuse and potential for reduction of environmental impact. Additionally reference is made to animal manures and land management practices where these relate to the management of crop nutrients and minimising the risk of water pollution by diffuse losses from agricultural land.

The national fertiliser inventories are presented in Annexes 2 –12 of this report.

Use of Mineral Fertilisers in the 11 DRB Countries

A range of mineral fertiliser products containing nitrogen (N) and phosphorus (P) are available to farmers in DRB countries. There are no consistent patterns to the products being, except to say that the most commonly used products in any country are inevitably those that are locally the cheapest such as ammonium nitrate, calcium ammonium nitrate (CAN) and urea.

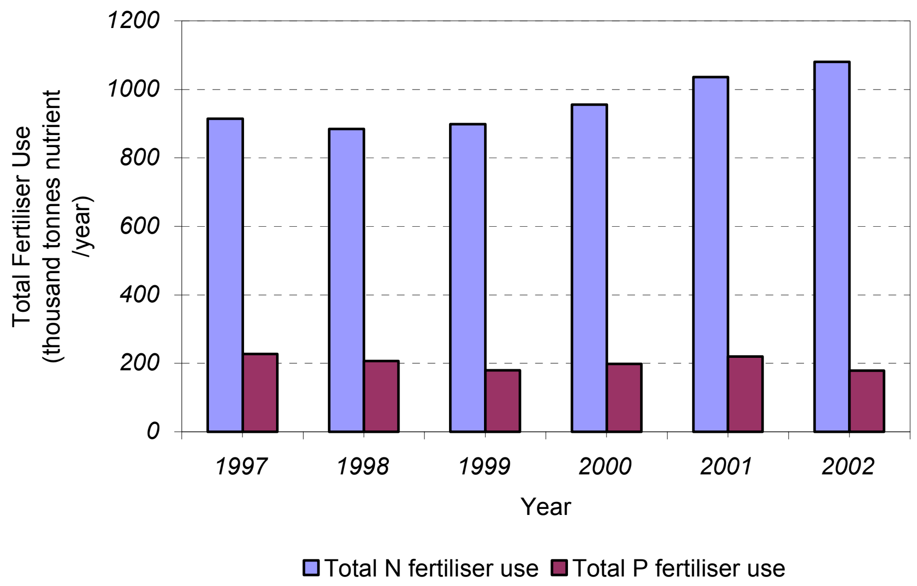
Figure 2 below shows the annual total consumption (millions tonnes) of N and P mineral fertilisers in all DRB countries under study during the period 1997 – 2002. Whilst there has been little change in total P fertiliser use, there appears to be a discernable trend towards increasing N fertiliser consumption with an 18% increase between 1997 and 2002.

However, this aggregate increase obscures:

- a 30% increase in total N fertiliser consumption in the 4 DRB countries preparing for EU accession – either as the result of more land being fertilised by farmers and/or an increase in fertiliser application rate (i.e. farmers applying more fertiliser N per hectare).
- reductions of up to 50% in total N fertiliser consumption in some of the other central and lower DRB countries, including Romania, Ukraine and Serbia & Montenegro

The existing trend towards increasing fertiliser N consumption in the 4 acceding countries is a cause for concern since it is likely to be reinforced by EU enlargement and the implementation of the Common Agricultural Policy (CAP) leading to increasing areas of cereals and oilseeds being grown due to the availability of EU direct payments; increased intensification of crop production, particularly in the more favourable areas with better growing conditions, and a possible reduction in mixed cropping due to an increase in large-scale cereal monocultures.

Figure 2: Annual total consumption of N and P (thousand tonnes nutrient/year) as fertiliser products in the central and lower DRB countries (1997 - 2002)



Source: Data submitted by GFA National Experts

Problems Associated with Mineral Fertilisers, Manure Application and Land Management in the DRB Countries

The total amounts of mineral fertiliser applied to agricultural land are certainly an important consideration in assessing the environmental impact of agriculture upon water quality and there is also little doubt that the reduction in fertiliser use in the central and lower DRB countries has contributed to a reduction in nutrient losses.

However, the environmental impact of fertiliser use is also closely related both to:

a) the way in which farmers apply fertilisers to their crops and

b) the overall management of their farming system

In particular, the changes in management practice required to optimise the use of mineral fertilisers and avoid their misuse are related to the application of manure and slurry to agricultural land, as well as other soil management practices such as cultivations. Typical problems and "bad practice" identified by the GFA national experts during preparation of the national fertiliser inventories (Annexes 2 - 12) included:

- there is a widespread ignorance of ideas such as "pollution" or environment" amongst farmers and no information on the importance of managing fertilisers and manures properly
- farmers often consider manure as a "waste product" rather than a source of nutrients that should be used carefully to save money spent on fertilisers
- the agricultural workforce often consists of more elderly people familiar only with previous farming methods and who have little (if any) agricultural education and do not understand the importance of applying fertilisers and manures correctly to the soil
- the machinery used for spreading fertilisers is outdated and not appropriate for the modern agricultural operations – consequently application is uneven and commonly results in areas of "under" and "over"-fertilisation. Farmers do not have the knowledge or experience to adjust/operate the equipment correctly
- many cheaper mineral fertilisers are only "milled" and during storage become compacted again which makes uniform spreading very difficult
- fertilisers and manures are commonly stored in unauthorised places where there is a risk of causing pollution
- there is a tendency in some areas for farmers to grow the same crop (or same simple rotation of crops) for many years without application of fertiliser or manures. This is leading to a serious decline in soil fertility and the risk of increasing soil erosion due to loss of soil organic matter
- farmers do not consider the nutrient requirements of the crops they are applying fertilisers (and manures) to
- it is not very common for farmers to practice soil testing before deciding where to apply fertilisers and manures and in what quantities
- farmers and agronomists do not sufficiently recognise the potential value of nutrients in livestock manure. Consequently the application rate of fertilisers is not adjusted and nutrients are wasted because they are surplus to the crop's requirement
- bad timing of fertiliser application is a common problem, especially when applying large amounts of fertiliser to higher value crops such as vegetables and potatoes. There are many reasons for this including poor knowledge and no access to agronomic advice, but also lack of necessary equipment when needed
- application of nitrogen to soil in autumn before planting a spring crop is common practice in some countries. It is not understood that the nitrogen can be lost over winter. Spreading fertiliser and manure to frozen and snow covered ground is also common in some countries
- over-application of fertiliser N at the time of sowing a crop is a common problem

- compound fertilisers are often applied with inappropriate balance of nutrients and there is tendency to under-fertilise with P and K
- nitrate losses from agricultural land are associated with farming practice not just the rate of fertiliser or manure application – factors that continue to contribute to high levels of nitrate leaching are poor timing of application, regular cultivations and the ploughing of grassland, legumes and other crop residues
- fertilisers (and manures) are spread too closely to surface waters – rivers, lakes, ponds, streams and springs
- fertilisers (and manures) are spread on sloping land where there is the risk of surface run-off from heavy rain washing them into nearby rivers and streams
- even though the number of farm animals has declined and the quantity of animal wastes produced is less, most farmers do not have good storage facilities for manure and slurry – therefore manures and slurries are being applied at inappropriate times (e.g. autumn and winter) when there is a high risk of leaching or run-off
- because of simplified tax systems in many countries for households and private agricultural plots, including small farms, there is no official obligation for them to have a book-keeping system. As a result they do not keep records of their purchases or use of fertilisers, manures or other relevant information (e.g. crop yields or sales) and there is therefore no reliable information regarding application of fertilizers

Potential for Policy Reform in EU Context

As noted in the other summary reports, this review of fertiliser use is undertaken during a period of great change in the Danube River Basin (DRB) with 4 countries (Hungary, Czech Republic, Slovakia and Slovenia) in the final stages of preparation for accession to the EU in 2004 and 2 countries (Bulgaria and Romania) preparing for EU accession sometime after 2004. The policy-making context for agricultural pollution control in the DRB is therefore undergoing significant change and preparation for joining the EU is currently a major driving force for the reform of agricultural pollution control policies in the region.

This includes:

Adoption of EU Legislation

In the European Union, there are three Directives that address the problem of excess nutrient losses from agriculture:

- *Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive)*
- *Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources*
- *Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive)*

Of these, only the Nitrate Directive 91/676 currently places any direct obligation upon farmers and for over a decade has effectively promoted a variety of good practices for reducing diffuse nitrate pollution by nitrates through a variety of good agricultural practices, including good practices in fertiliser and manure application. Unfortunately, the Nitrates Directive has consistently failed to meet its environmental objectives and has suffered from both considerable resistance by the EU agricultural community and poor implementation by many Member States. One problem has been the lack of appropriate tools – particularly economic instruments - to support implementation of the Directive. For example, Member States have not been able to offer farmers agri-environment payments to encourage them to meet the obligatory reductions in fertiliser application required in designated "nitrate vulnerable zones" under the Nitrate Directive because EU rules currently prevent agri-environment payments being made to farmers for complying with the requirements of EU legislation.

It is now hoped that the Water Framework Directive (WFD) will offer an additional policy tool for reducing agricultural water pollution – provided that appropriate policy instruments can be developed/utilised by the WFD to address the pressures upon water resources from agriculture. Consequently there is much interest in using the policy tools available in the Common Agricultural Policy (CAP) to support and implement the WFD, including the Pillar 1 – Market Support Measures and the Pillar 2 - Rural Development Measures.

Financial Incentives for Pollution Control

As mentioned above, the EU Rural Development Regulation 1257/1999 (the "second pillar" of the CAP) makes provision for Member States to encourage more environmentally-friendly farming methods, including practices and actions that reduce the risk of agricultural pollution. This offers a good opportunity for supporting the control of nutrient pollution in those DRB countries joining the EU, by allowing them to develop EU co-financed schemes that:

a) offer grant-aided investment (up to 50%) in agricultural holdings that helps to *"...preserve and improve the natural environment"* – for example, by purchasing new manure storage facilities or purchasing more up-to-date equipment for fertiliser and manure application
b) training farmers for the *"...application of production practices compatible with the maintenance and enhancement of the landscape and the protection of the environment"* – this includes:
   - training for organic farming
   - training for farming management practices with a specific environmental protection objective
c) introducing agri-environment schemes that offer area payments to support *"...agricultural production methods designed to protect the environment and to maintain the countryside"* – this is very important tool for supporting the adoption of organic farming, as well other pollution control techniques such as uncultivated buffer strips, conversion of arable to pasture land and the introduction of more diverse crop rotations.

While the four DRB countries (Czech Republic, Slovakia, Hungary and Slovenia) joining the EU in 2004 will shortly be implementing national agri-environment programmes, two DRB countries (Romania and Bulgaria) are unlikely to join the EU until at least 2007. In these latter countries, financial assistance is also available for developing and implementing "pilot" agri-environment measures with SAPARD co-funding – the Special Pre-accession Programme for Agriculture and Rural Development.

Additionally, following agreement on proposals arising from the recent Mid-term Review of the CAP a new "meeting EU standards" measure will be introduced to "*help farmers adapt to the introduction of demanding standards based on EU legislation…concerning the environment, public, animal and plant health, animal welfare and occupational safety*". This is potentially a very useful tool for reducing pollution and some of the acceding countries are proposing to make extensive use of it to improve manure storage and management facilities on farms.

Developing the EU Concept of "Cross Compliance"

The concept of cross-compliance in agriculture (setting conditions which farmers have to meet in order to be eligible for direct government support) has been growing in importance since the 1970s. After many years of debate it is now also seen as an important policy tool in the EU to help improve standards in farming and protect the environment.

The "Agenda 2000" reform of the CAP introduced cross-compliance for the first time as a key policy instrument for improving the environmental performance of farmers in the EU by:

a) allowing Member States to attach environmental conditions to the so-called 'First Pillar' of the CAP, and;
b) requiring Member States to define verifiable standards of Good Farming Practice (GFP) for farmers to follow before they could certain receive funds under the Rural Development Regulation (No. 1257/1999) - the so-called 'Second Pillar' of the CAP.

Member States showed relatively little interest in the option for voluntary cross-compliance introduced in the original "Agenda 2000" CAP reform. In most countries it was not adopted at all, in others it appears only to have been used to address very specific environmental problems e.g. limits on pesticide use in maize in the Netherlands. The June 2003 Mid-term CAP reform package however now **obliges** all Member States to have a system of cross compliance in place for all direct support schemes from January 2005 in accordance with the revised 'Common Rules' Regulation 1782/2003.

Good Practice for Improving the Management of Fertiliser and Manures

In order to reduce the risk of diffuse pollution by nutrients (N and P) from agriculture it is necessary to encourage practical farm management techniques that minimise the opportunities for nutrients to accumulate in a form that is susceptible to loss. By using current and evolving scientific knowledge it is possible to develop simple practical guidelines for the management of the nutrient inputs most commonly used by farmers – namely mineral fertilisers and manures. These should be applicable to all farmers at little or no cost thereby minimising the need for financial incentives – furthermore, it should always be stressed to farmers that improvements in nutrient management also means improvements in productivity, cost-effectiveness and ultimately profit.

The following typical management practices are commonly promoted to reduce the risk of nitrate leaching (especially during periods of high risk, such as the autumn and winter months):

1. Ensure that fertiliser N is applied according to the crop's requirement and taking account of:
   - the crop species/variety, expected yield and required quality
   - the natural supply of N from the soil, including N released from soil organic matter, crop residues and applied manure/slurry
2. Avoid applications of N fertilisers and manure/slurry in autumn and very early spring when crop requirements for N are very low
3. Limit the application rate of organic manure/slurry to ensure that N supply does not exceed crop requirements – this includes applying in smaller quantities at regular intervals to match more closely the crops requirement for nutrients during the growing season
4. Take special care when applying fertilisers and manure/slurry on fields where there is a risk of run-off to surface waters
5. When applying fertilizers/manures, ensure that an adequate distance (a "buffer zone") is kept away from surface waters to avoid the risk of direct pollution
6. Ensure accurate calibration of fertiliser spreading equipment to minimise the risk of excessive application
7. Minimise the period when the soil is left bare and susceptible to nitrate leaching by increasing the area sown to winter crops, cover crops and grassland, whilst decreasing the areas sown to spring crops
8. Sow winter crops early in the autumn to increase nitrate uptake prior to the onset of the winter leaching period
9. Restrict the ploughing of old grassland.since this leads to excessive amounts of nitrate being produced by the natural process of mineralisation and commonly leads to high levels of nitrate leaching

It must be remembered, however, that diffuse nutrient losses from agriculture are greatly influenced by climate, soil type, cropping system and the forms and quantity of fertiliser and manure applied. Additionally diffuse losses of P are influenced by factors such as the vulnerability of soil to erosion. The typical management practices outlined above must therefore always be elaborated and expanded upon according to different national – and ideally regional/local – contexts.

Technological and scientific developments will also play a major role in continuing to improve the efficiency of nutrient use in agriculture – for example, the use of high technology for targeting fertiliser inputs in cereal production through the use of so-called "precision farming techniques" offers considerable opportunity to both improve the efficiency and profitability of fertiliser use, as well further reduce nutrient losses. But for the moment such technology remains very capital intensive and beyond the reach of most farmers.

The important thing is to ensure that the practical guidance developed for "good practice" is flexible and pragmatic – this is likely to involve the combination of both new technologies and more traditional nutrient conserving techniques such as those outlined above.

Recommendations for Policy Reform in DRB Countries

Despite the relatively low levels (compared to many EU Member States) of mineral fertiliser and manure currently applied to agricultural land in the central and lower DRB region, national governments should take seriously the risk of diffuse pollution arising from fertiliser and manure application. The following objectives relating to fertiliser and manure application are recommended for all national strategies aiming to control nutrient pollution from agriculture. Comments are also included on policy instruments that should be adopted where appropriate to national context:

OBJECTIVE 1: Develop greater understanding at a national/regional level of the relationship between agricultural practice (fertiliser, manure and land management) and the risk of diffuse nutrient pollution

1.1 **Establish progressive and well-funded research programmes** – whilst scientific understanding of nutrient losses from agricultural land and the related transport processes to ground and surface waters has increased in recent years this cannot be applied uniformly across the DRB for the development of good/best practice. Country/regional specific guidance for farmers must be based upon an understanding of the behaviour of nutrients in the specific agronomic, environmental and socio-economic context of each country. For example:

- the nutrient content of animal manures need to be quantified to aid more precise application
- the nutrient losses from different components of the farm system to be measures and the causes of these losses established
- the underlying soil processes affecting nutrient availability (e.g. soil mineralisation) need to be better understood

OBJECTIVE 2: Develop appropriate policy instruments and institutional arrangements for promoting better management of fertilisers and manures

2.1 **Raise Farmer Awareness of Good Practice** - simple and easy to understand information materials, combined with well-targeted publicity campaigns, can be very effective at raising farmers' awareness of the importance of improving the management of fertilisers and manures – a key message to communicate is that better nutrient management increases productivity, saves money and improves profitability.

2.2 **Develop and Promote National Codes of Good Practice** – national authorities should agree upon clear and simple codes of voluntary good practice for fertiliser and manure management. This should be specific to national context and ideally linked to/derived from progressive and well-funded research programme (see 1.1 above)

2.3 **Use Economic Instruments to Promote Good Practice** – where government schemes are providing support to farmers then the principle of "environmental cross-compliance" can be applied. This involves the establishment of certain conditions that farmers have to meet in order to be eligible to receive government support and can easily be adapted to the promotion of good practice for fertiliser and manure management. Additionally, payments to farmers from agri-environment schemes (where implemented) can be conditional upon certain standards for fertiliser and manure management. Appropriate financial disincentives might also be developed.

2.4 **Develop Appropriate Extension Capacity** – agricultural extension services play a key role in raising awareness and improving the technical skills of farmers with respect to good practice for fertiliser and manure management, however they often require support in developing the necessary capacity to do this. National funding should be provided for the training of advisers in good practice and modern extension techniques, as well as the development of appropriate institutional frameworks for extension services (including the link to progressive and well-funded research programmes – see 1.1 above)

OBJECTIVE 3: Promote certified organic farming and other low input farming systems as viable alternatives to the conventional use of fertilisers

3.1 **Raise Farmer Awareness** – alternative farming systems, such as organic farming, should be actively promoted to farmers through the preparation of simple and easy to understand information materials. Organic farming is the most well-developed of all alternative farming systems and has good potential to reduce nutrient losses through the avoidance of the most soluble forms of mineral fertiliser, more rational use of manures and use of more diverse crop rotations (e.g. increased winter crop cover) - whilst also contributing to the reduction of pesticide pollution etc.

3.2 **Develop Relevant Legislation** – national legislation for the certification and inspection of organic farming systems in compliance with internationally recognised standards (particularly those in accordance with EC legislation) should be developed and implemented as a high priority in order to promote the development of domestic markets and international trade

3.3 **Develop Appropriate Extension Capacity** – agricultural extension services and farm advisers play a fundamental role in the re-orientation of farmers towards alternative production systems, particularly those such as organic farming, which require higher levels of technical knowledge and management. National funding should be provided for the development of appropriate extension capacity as 2.4 above

3.4 **Use Economic Instruments to Promote Organic Farming** – farmers converting to organic farming techniques can incur certain additional costs associated with reductions in input, establishment of new crop rotations, adoption of new technologies etc. These costs can be a significant obstacle to farmers deciding making the transition from a conventional farming system. Where funds are available, national authorities should encourage farmers to convert to organic farming by offering appropriate levels of compensatory payment. Since organic farmers often have problems to sell or export their products, the marketing of organically-grown products should also be supported by governmental campaigns and action.

Introduction

Overview

Modern agricultural production systems have developed by making widespread use of mineral fertilisers to replace the traditional reliance upon crop rotations and animal manures to maintain and enhance soil fertility and support profitable crop production.

The two most important plant nutrients applied as mineral fertilisers are nitrogen (N) and phosphorus (P). Both occur naturally in the soil and are essential for crop growth.

N occurs within the soil in the simple ionic forms of ammonium (NH_4^+) and nitrate (NO_3^-) which plants can easily absorb and utilise. Of the elements essential for plant growth, N is required in the greatest quantity by agricultural crops. The exception to this rule-of-thumb being those crops which form large underground storage organs, notably potatoes, since these also require large quantities of P and potassium (K). However, as well as being the most important crop nutrient in agriculture, N is also a potential environmental pollutant since when found in the wrong place, at the wrong time and in the wrong form, N can cause significant ecological disturbance and, in certain circumstances, may possibly pose a hazard to human health.

The dominant feature of the behaviour of P in the soil is its strong adsorption to the surfaces of soil particles and until 20-30 years ago it was thought that P was held so strongly in the soil that its significance as a cause of water pollution was negligible. However, it is now understood that phosphate pollution is a major contributing factor to the occurrence of eutrophic waters, algal blooms and other ecologically-damaging effects. Furthermore, agricultural land is increasingly recognised to be one of the largest non-point sources of P reaching surface waters.

Both N and P are transient in the soil and the amounts available in the soil at any time to meet the needs of a growing crop are the product of a network of physical, biological and chemical pathways through which N and P move – the so-called N and P "cycles".

N and P can enter the soil in a number of ways and in a number of different forms. In modern agriculture it has become broadly accepted that the N and P content of the soil should be regularly supplemented with mineral fertilisers and this has become common practice where N and P fertilisers can be easily afforded by farmers.

The most commonly used mineral fertilisers containing N and P are listed in Table 1.

Table 1: N- and P-containing Chemicals and Materials Commonly Used in Mineral Fertilisers

	Chemicals/Materials	**N Content (%)**	**P Content (%)**
"Straight" Fertilisers	Ammonium sulphate	21	
	Ammonium nitrate	35	
	Calcium nitrate	17	
	Urea	46	
	Anhydrous ammonia	82	
	Aqueous ammonia	25-29	
	Rock phosphate		14-17
	Triple superphosphate		19-23
"Compound" Fertilisers	Mono-ammonium phosphate	11-12	26
	Di-ammonium phosphate	18-21	23

Aim of this Report

The aim of this report is to develop an inventory of fertiliser market products for the central and lower DRB on a country-by-country basis and to review their typical use, misuse and potential for reduction of environmental impact.

Additionally reference is made to animal manures and land management practices where these relate to the management of crop nutrients and minimising the risk of water pollution by diffuse losses from agricultural land.

The DRB Context

The collapse of the centrally-planned economies of central and eastern Europe in the early 1990s caused a social and economic crisis that profoundly affected agriculture in the central and lower Danube River Basin (DRB).

The market situation changed drastically, with average consumer income decreasing, causing a lowered demand for agricultural products. In addition, important foreign markets, such as the former Soviet Union, were lost. At the same time, large-scale restructuring of the agricultural sector occurred. Land was privatised and most of the collectivised/state farm structures were dismantled. However, in many of the former communist DRB countries the registration of new landownership progressed only slowly (e.g. due to the complexities of the privatisation process, poor management, disputes etc.), adding to the uncertainties of the individual farmer.

The economic crisis also put pressure on national budgets. As a result, state support to the agricultural sector was reduced drastically. To make things worse, capital and credit facilities were lacking in the private sector. These changes inevitably led to a significant reduction in agricultural productivity in the region, including a decline in the use of external inputs such as mineral fertilisers[2].

Reliable data on mineral fertiliser use in the central and lower DRB region are not available for the decades leading up to 1990. However, the limited data available from the FAOSTAT database shows that after rising strongly for three decades the use of N fertilisers (kg N/ha) by farmers in the former communist DRB countries dropped by approximately 50% around the year 1990 and is now far below the EU average (Figure 1). The decline in fertiliser use was more severe in some countries than others – in Bulgaria, the average application rate of fertiliser N fell from 109.9 kg N/ha in 1981 to 29.9 kg N/ha in 1999. Similar declines can also be observed for phosphate (P) and potash (K) use – again in Bulgaria, the average application rate of P and K fell from 90.2 kg P_2O_5/ha and 26.8 kg K_2O/ha in 1981 to 2.2 kg P_2O_5/ha and 1.2 kg K_2O/ha in 1999[3].

In all countries, the reduction in the use of mineral fertilisers was the result of economic necessity rather than environmental awareness. The lack of working capital on new private holdings and remaining collective farms made it difficult to buy in more than the minimum of farm inputs. For most farmers, the low level and fluctuation of agricultural product prices, as well as uncertainty over land ownership, have it made it advisable to operate with a minimum of costs since there is no guarantee of any returns on investment, including farm inputs.

At the same time, significant changes also occurred in livestock production. The de-collectivisation and privatisation of the state-controlled animal breeding complexes was particularly dramatic in many DRB countries and led to a significant decline in livestock numbers by approximately 50% in most countries, as well as a major change in the way that farm animals are kept. For example, when state-controlled dairy units were liquidated cattle were commonly distributed amongst former employees. However, new owners were short of facilities for keeping cattle, feed was expensive and land was not easy to buy or lease ahead of the land restitution process. These circumstances were not favourable to the formation of new dairy farms and many cattle were sold for slaughter.

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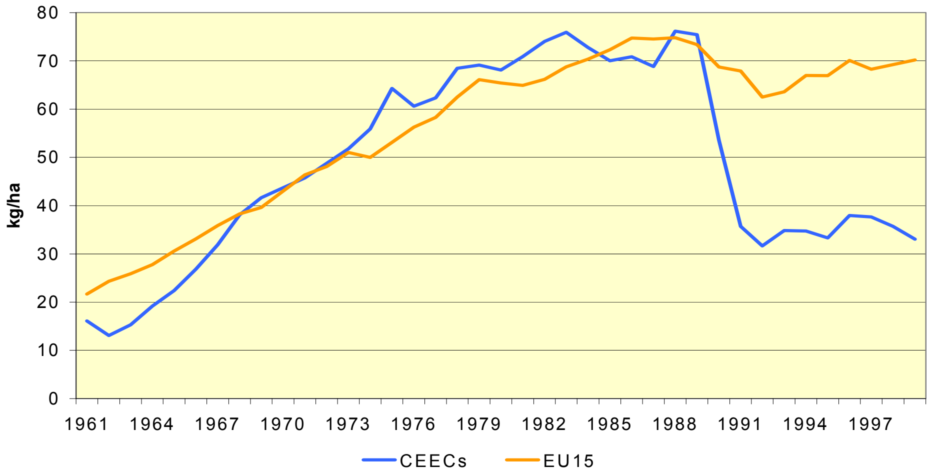
[2] "Mineral fertilisers" are defined as nutrient-containing fertiliser products which have been manufactured for sale to farmers

[3] Data supplied by the National Statistical Institute, Sofia

Figure 1: Long-term trends in nitrogen fertiliser use (kg N/ha) in selected central and lower DRB countries and EU Member States[4]



Source: FAOSTAT - database of the UN Food and Agriculture Organization.

With the decline in livestock numbers there has also been a decline in the availability of manure as a traditional source of crop nutrients. When taken together with the reduced use of mineral fertilisers, this has resulted in a decline in the nutrient balance[5] of many agricultural soils in the middle and lower DRB countries to the point that many agricultural scientists in the region are concerned that farmers are now relying upon the fertility reserves of the soil to maintain their relatively low levels of crop yield.

The long-term changes in the N balance/surplus (kg N/ha) of agricultural areas in selected DRB countries are shown in Figure 2 below. All the countries shown are characterised by a slow long-term increase in N balance from the 1950s/1960s until the end of the 1970s – the period of most rapid intensification of agricultural production in most European countries. Depending upon the original starting level, the N balance/surplus observed in most countries reached a relatively high, but stable plateau in the 1980s. During the 1990s, however, the changes in N balance/surplus observed are very different between:

- the gradual decline seen in the upper DRB countries of Germany and Austria, and
- the dramatic fall of 40-50 kg N/ha seen within a few years in the former communist countries of the central and lower DRB.

Changes in N balance/surplus are commonly used as an indicator to highlight areas potentially at risk from pollution[6] – consequently the observed fall in N balance in the countries of the central and lower suggests a significant reduction in the risk of surplus N being lost from agricultural land to the wider

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[4] Due to limited data availability, the description of the trend in N fertiliser consumption is limited to the following DRB countries: Bulgaria, Czech Republic, Hungary, Romania and Slovakia

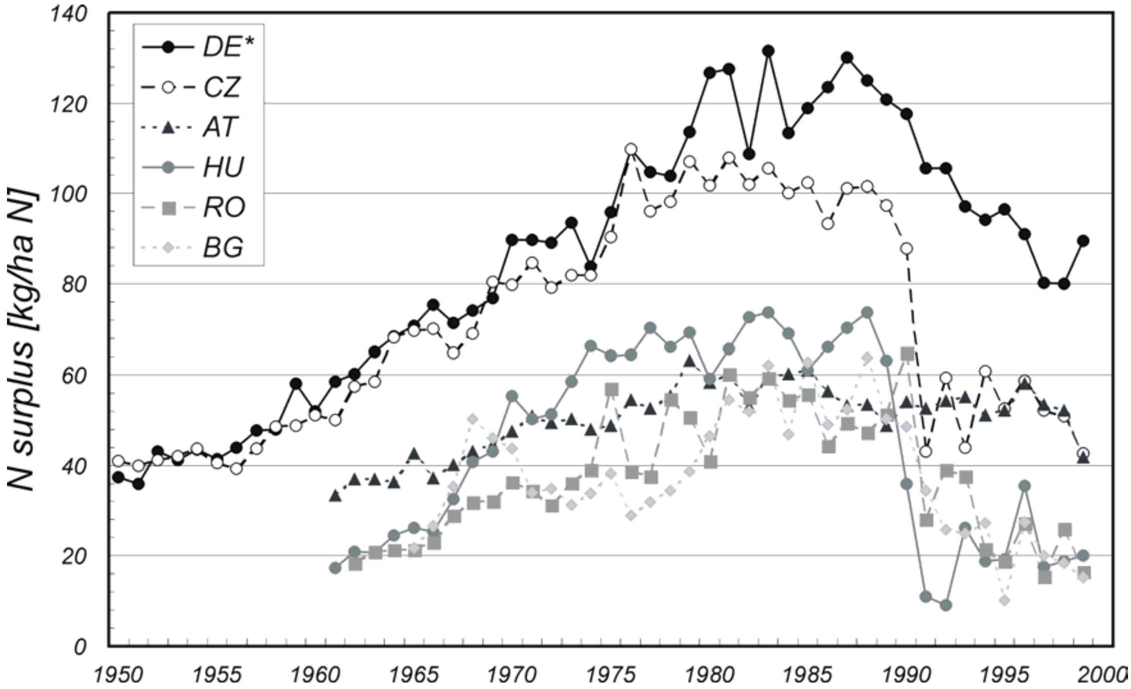
[5] Nutrient balances (particularly nitrogen balances) are a key agri-environmental indicator and calculate the balance between nutrients added to an agricultural system (fertilisers, livestock manures, biological N fixation, atmospheric deposition etc.) and nutrients removed from the system (marketable products) per hectare of agricultural land. A deficit (negative balance) suggests that the system is losing fertility, while a large surplus (large positive balance) indicates the risk of nutrient loss and therefore potential pollution

[6] Although the calculation of N surplus cannot be immediately interpreted as an indicator of loss of nitrogen to water. The balance between inputs and outputs for a system contains all potential losses, plus any change in the store of nitrogen, principally within the soil. The potential loss pathways for nitrogen are:

- to air as ammonia by direct volatilisation after spreading of manure on the field
- to air as nitrous oxide and nitrogen gas by denitrification
- to groundwater by nitrate leaching and in organic compounds
- to rivers and lakes through run-off after heavy rainfall

environment, notably by nitrate leaching.

Figure 2: Long-term changes in the N balance (kg N/ha) of agricultural areas in selected DRB countries (including Austria and Germany – Bavaria and Baden-Wuerttemburg only)



Source: Various – compiled by Schreiber *et al.* (2003)[7]

Table 2 further presents the most recent calculations (1998-2000) of N balance/surplus for all national territories falling within the DRB together with the agricultural area of each country within the catchment and the estimated N loss by diffuse pollution (tonnes N/year) from this agricultural area. The national territories are divided between the upper DRB countries (Germany and Austria) that are not the subject of this project and the middle/lower DRB countries that are under study. Within each category the countries are ranked according to estimated N balance/surplus.

There is a wide variation in the estimated N balances of the agricultural areas of the central and lower DRB countries ranging from 73.6 kg N/ha in Slovenia to 11.9 kg N/ha in Serbia & Montenegro. Furthermore the countries fall into two distinct groups that currently suggest there is:

- the highest potential risk of N losses, such as nitrate leaching, occurring from agricultural land in the territories of Slovenia, Czech Republic and Croatia – although the N surplus in these countries is less than in Germany and previously reported in other EU Member States (e.g. national N surpluses for farmland in Luxembourg and the Netherlands were estimated to be 121 and 213 kg N/ha respectively in 1995[8])
- a lower risk of N loss from the remaining countries all of which have N surpluses estimated to be less than 25 kg N/ha.

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[7] Schreiber, H. *et al.* (2003). *Harmonised Inventory of Point and Diffuse Emissions of Nitrogen and Phosphorous for a Transboundary River Basin*. Research Report 200 22 232, Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, Germany.

[8] Source: EUROSTAT quoted by EEA (2000). *Environmental Signals 2000*. Environmental Assessment Report No.6, European Environment Agency, Copenhagen

However, this situation provides no grounds for complacency in the lower and middle DRB countries since whilst national nutrient balances are useful tools for tracking change and making comparisons between countries/national territories, they:

- may hide considerable regional or local nutrient surpluses that are susceptible to high losses particularly where they occur on vulnerable soils or where groundwater is close to the surface
- do not provide any information about how well farmers are managing the (often limited) amounts of mineral fertiliser and manure that they are applying
- take no account of the risk of small point source pollution occurring from farms wherever manures and other livestock wastes are poorly handled or stored

Table 2: Summary of data (1998–2000) from the MONERIS model showing a) estimates of nitrogen balance/surplus (kg N/ha), b) agricultural area (km^2) and c) estimated nitrogen loss by diffuse pollution (tonnes N/year) for all national territories within the Danube river basin catchment

	Country	Estimated N Balance (kg N/ha)[9]	Agricultural Area within Danube Catchment Area (km^2)	Estimated N Loss by Diffuse Pollution (tonnes N/year)[10]
Upper DRB Countries	Germany	90.9	32 839	75 553
	Austria	44.0	29 639	28 900
Middle and Lower DRB Countries	Slovenia	73.6	6 153	10 629
	Czech Republic	46.8	13 054	16 314
	Croatia	39.2	18 011	14 886
	Slovakia	23.9	23 890	16 702
	Hungary	21.9	66 400	8 700
	Romania	21.5	112 931	68 366
	Moldova	19.1	11 474	2 113
	Bulgaria	16.8	35 946	18 197
	Bosnia & Herzegovina	15.9	13 778	7 332
	Ukraine	15.7	19 433	13 976
	Serbia & Montenegro	11.9	46 686	10 487
	Other		296	388
		TOTALS	**430 530** km^2	**292 543** t N/year

Source: Schreiber *et al.* (2003)[11] and personal communication with the MONERIS project, IGB Berlin

[9] Nutrient balances for the Danube river catchment were prepared for the MONERIS model using the standard OECD soil surface nitrogen balance methodology with crop and livestock data supplied by national consultants for selected countries. Where these data were not available, figures from the OECD and FAO databases were used

[10] The total contribution of agricultural non-point source pollution to nutrient emissions into the Danube river is estimated by the MONERIS model (IGB Berlin) as the sum of losses via Surface Run-off, Erosion, Tile Drainage and Groundwater less Background losses

[11] Schreiber, H. *et al.* (2003). *Harmonised Inventory of Point and Diffuse Emissions of Nitrogen and Phosphorous for a Transboundary River Basin*. Research Report 200 22 232, Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, Germany.

Methodology

Due to the limited availability of data sources on mineral fertiliser use in the region, national experts in each of the DRB countries under study were asked to undertake a survey of:

1. **amounts** of mineral N and P fertilisers typically applied in their won country and **how** they are used (e.g. what crops are they applied to)
2. any information available on **bad practice** by farmers regarding the use of these fertilisers

A simple questionnaire approach was used that took the experts through 4 key steps (See Annex 1):

Step 1 – identification of the types of N and P mineral fertiliser (including the nutrient-containing chemicals and materials) that are commonly used in agriculture and horticulture.

Step 2 – estimation of the total consumption of N and P mineral fertilisers by farmers for the years 1997 - 2002. All data collected was for the amount of nutrient (N or P) not the amount of fertiliser product/chemical (for example, 1 tonne of ammonium nitrate typically contains only 345 kg of nitrogen)

Step 3 – collection of information on the characteristics of N and P mineral fertiliser use by farmers, including:

- approximately what percentage of the crops grown currently have mineral fertilisers applied to them
- the current average or “typical” application rate (kg per ha) for N and P fertilisers
- the typical time of fertiliser application (e.g. in autumn or spring)

Step 4 – identification of problems relating to the use of mineral fertilisers, including known “bad practice” such as:

- using application rates that are higher than recommended rates (unlikely in many countries)
- poor application due to old or poorly maintained equipment
- spreading too closely to water sources e.g. streams and rivers
- applying mineral fertiliser at an inappropriate time of year (i.e. when the crop is not growing)

The results of the survey and the inventories prepared for each country are included in Annexes 2 – 12 of this report.

Use of Mineral Fertilisers in the 11 Central and Lower DRB Countries

A range of mineral fertiliser products containing nitrogen (N) and phosphorus (P) are available to farmers in DRB countries – those products typically being used by farmers are summarised in Table 3. There are no consistent patterns to the products being, except to say that the most commonly used products in any country are inevitably those that are locally the cheapest such as ammonium nitrate, calcium ammonium nitrate (CAN) and urea.

Figure 3 shows the annual total consumption (millions tonnes) of N and P mineral fertilisers in all DRB countries under study during the period 1997 – 2002. Whilst there has been little change in total P fertiliser use, there appears to be a discernable trend towards increasing N fertiliser consumption with an 18% increase between 1997 and 2002.

However, this aggregate increase obscures:

- a 30% increase in total N fertiliser consumption in the 4 DRB countries preparing for EU accession – either as the result of more land being fertilised by farmers and/or an increase in fertiliser application rate (i.e. farmers applying more fertiliser N per hectare).
- reductions of up to 50% in total N fertiliser consumption in some of the other central and lower DRB countries, including Romania, Ukraine and Serbia & Montenegro

The existing trend towards increasing fertiliser N consumption in the 4 acceding countries is a cause for concern since it is likely to be reinforced by EU enlargement and the implementation of the Common Agricultural Policy (CAP) leading to increasing areas of cereals and oilseeds being grown due to the availability of EU direct payments; increased intensification of crop production, particularly in the more favourable areas with better growing conditions, and a possible reduction in mixed cropping due to an increase in large-scale cereal monocultures.

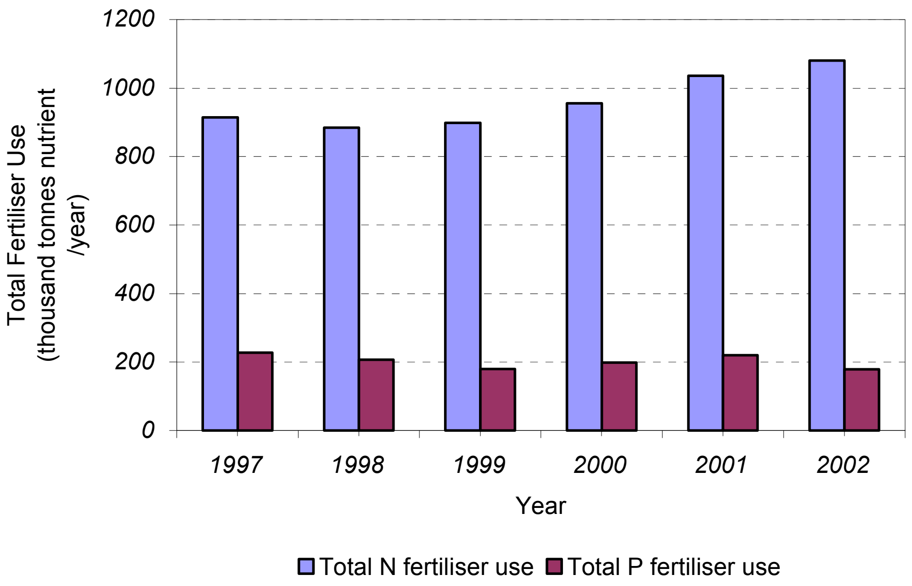
Detailed information from the survey of typical fertiliser use is included in Annexes 2 – 12, but Table 4 summarises the results for N fertiliser use on wheat – a crop that is commonly grown in all DRB countries. The results show a wide variety of typical practices with some surprisingly high application rates reported in certain countries (e.g. CS!) – however there appear to be 3 basic groups of typical fertiliser practice:

- virtually all of the crop area receives relatively high N application e.g. HR and HU
- virtually all of the crop area receives moderate N application e.g. SI and SK
- significant proportion of the crop areas receives no N application and the remaining crop areas receives small or moderate N application e.g. RO and MD

Table 3: Types of N and P Fertiliser Commonly Used by Farmers in DRB Countries
(Note that the most commonly used fertiliser products for each country are marked with ✓✓)

Fertiliser Type	% N/P	DRB Country										
		BH	BG	HR	CZ	HU	MD	RO	SK	SL	UA	CS
Straight N Fertilisers:												
Ammonium sulphate	21% N	✓	✓		✓	✓		✓	✓	✓	✓	
Ammonium nitrate	30-35% N	✓	✓✓	✓		✓	✓✓	✓	✓	✓	✓	✓
Calcium nitrate	15% N	✓			✓	✓				✓	✓	✓
Calcium ammonium nitrate	27% N	✓✓		✓✓	✓✓	✓			✓✓	✓✓		
Urea	46% N	✓✓		✓✓	✓	✓✓	✓	✓	✓	✓	✓	✓
Anhydrous ammonia	82% N	✓				✓						
Aqueous ammonia	25-29% N	✓			✓✓			✓				
Other		✓	✓	✓		✓			✓	✓	✓	✓
Straight P Fertilisers:												
Rock phosphate		✓	✓									✓
Superphosphate	< 25% P_2O_5		✓			✓			✓✓		✓	
Concentrated superphosphate	> 25% P_2O_5	✓✓	✓		✓	✓		✓	✓			✓
Calcium phosphate		✓	✓									✓
Other		✓	✓			✓			✓			
Compound N-P-K Fertilisers:												
Mono-ammonium phosphate		✓	✓	✓✓	✓	✓	✓	✓	✓	✓	✓	✓
Di-ammonium phosphate		✓	✓			✓		✓				
Other		✓	✓		✓	✓	✓		✓	✓	✓	✓

Figure 3: Annual total consumption of N and P (thousand tonnes nutrient/year) as fertiliser products in the central and lower DRB countries (1997 - 2002)



Source: Data submitted by GFA National Experts

Table 4: Summary of typical fertiliser use on wheat in central and lower DRB countries

Country	Crop Receiving N Fertiliser	Typical Application (kg N/ha)	Typical Timing of Application	Comments
BH	50-60%	95-160	Autumn* & spring	Typical NPK fertiliser to apply in the seed-bed is 15:15:15 followed by to-dressing with CAN or urea in spring
BG	78%	86	Autumn* & spring	2001/2002 data
HR	95-100%	100-120	Autumn* & spring	
CZ	98%	90	Spring	
HU	95%	100-110	Autumn* & spring	
MD	60-75%	35-55	Spring	
RO	45%	30-66	Autumn*	Typical NPK fertiliser where used is 45:23:0.5
SK	90-100%	40-90	Mostly spring	
SI	90%	40-60	Autumn* & spring	
UA	60%	33	Spring	
CS	95%	250	Spring	

* for winter wheat

Problems Associated with Mineral Fertilisers, Manure Application and Land Management in the DRB Countries

The total amounts of mineral fertiliser applied to agricultural land are certainly an important consideration in assessing the environmental impact of agriculture upon water quality and there is also little doubt that the reduction in fertiliser use in the central and lower DRB countries has contributed to a reduction in nutrient losses.

However, the environmental impact of fertiliser use is also closely related both to:

c) the way in which farmers apply fertilisers to their crops and

d) the overall management of their farming system

In particular, the changes in management practice required to optimise the use of mineral fertilisers and avoid their misuse are related to the application of manure and slurry to agricultural land, as well as other soil management practices such as cultivations.

Typical problems and "bad practice" identified by the GFA national experts during preparation of the national fertiliser inventories (Annexes 2 - 12) included:

- there is a widespread ignorance of ideas such as "pollution" or environment" amongst farmers and no information on the importance of managing fertilisers and manures properly
- farmers often consider manure as a "waste product" rather than a source of nutrients that should be used carefully to save money spent on fertilisers
- the agricultural workforce often consists of more elderly people familiar only with previous farming methods and who have little (if any) agricultural education and do not understand the importance of applying fertilisers and manures correctly to the soil
- the machinery used for spreading fertilisers is outdated and not appropriate for the modern agricultural operations – consequently application is uneven and commonly results in areas of "under" and "over"-fertilisation. Farmers do not have the knowledge or experience to adjust/operate the equipment correctly
- many cheaper mineral fertilisers are only "milled" and during storage become compacted again which makes uniform spreading very difficult
- fertilisers and manures are commonly stored in unauthorised places where there is a risk of causing pollution
- there is a tendency in some areas for farmers to grow the same crop (or same simple rotation of crops) for many years without application of fertiliser or manures. This is leading to a serious decline in soil fertility and the risk of increasing soil erosion due to loss of soil organic matter
- farmers do not consider the nutrient requirements of the crops they are applying fertilisers (and manures) to
- it is not very common for farmers to practice soil testing before deciding where to apply fertilisers and manures and in what quantities
- farmers and agronomists do not sufficiently recognise the potential value of nutrients in livestock manure. Consequently the application rate of fertilisers is not adjusted and nutrients are wasted because they are surplus to the crop's requirement
- bad timing of fertiliser application is a common problem, especially when applying large amounts of fertiliser to higher value crops such as vegetables and potatoes. There are many reasons for this including poor knowledge and no access to agronomic advice, but also lack of necessary equipment when needed
- application of nitrogen to soil in autumn before planting a spring crop is common practice in some countries. It is not understood that the nitrogen can be lost over winter. Spreading fertiliser and manure to frozen and snow covered ground is also common in some countries

- over-application of fertiliser N at the time of sowing a crop is a common problem
- compound fertilisers are often applied with inappropriate balance of nutrients and there is tendency to under-fertilise with P and K
- nitrate losses from agricultural land are associated with farming practice not just the rate of fertiliser or manure application – factors that continue to contribute to high levels of nitrate leaching are poor timing of application, regular cultivations and the ploughing of grassland, legumes and other crop residues
- fertilisers (and manures) are spread too closely to surface waters – rivers, lakes, ponds, streams and springs
- fertilisers (and manures) are spread on sloping land where there is the risk of surface run-off from heavy rain washing them into nearby rivers and streams
- even though the number of farm animals has declined and the quantity of animal wastes produced is less, most farmers do not have good storage facilities for manure and slurry – therefore manures and slurries are being applied at inappropriate times (e.g. autumn and winter) when there is a high risk of leaching or run-off
- because of simplified tax systems in many countries for households and private agricultural plots, including small farms, there is no official obligation for them to have a book-keeping system. As a result they do not keep records of their purchases or use of fertilisers, manures or other relevant information (e.g. crop yields or sales) and there is therefore no reliable information regarding application of fertilizers

Potential for Policy Reform in EU Context

As noted in the other summary reports, this review of fertiliser use is undertaken during a period of great change in the Danube River Basin (DRB) with 4 countries (Hungary, Czech Republic, Slovakia and Slovenia) in the final stages of preparation for accession to the EU in 2004 and 2 countries (Bulgaria and Romania) preparing for EU accession sometime after 2004. The policy-making context for agricultural pollution control in the DRB is therefore undergoing significant change and preparation for joining the EU is currently a major driving force for the reform of agricultural pollution control policies in the region.

Adoption of EU Legislation

In the European Union, there are three Directives that address the problem of excess nutrient losses from agriculture (Table 5):

- *Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive)*
- *Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources*
- *Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive)*

Table 5: Summary of Legislation Addressing Nutrient Losses from Agriculture in the EU

Title of Legislation	Obligations
Directive 80/778/EEC on the quality of water intended for human consumption (the Drinking Water Directive) – to be replaced by Directive 98/83/EC from 2003	• The Drinking Water Directive (80/778) lays down standards for the quality of water intended for drinking or for use in food and drink manufacture in order to protect human health. • The Directive does not impact upon farmers directly, but sets a maximum admissible concentration of nitrate in drinking water supplies of 50 mg per litre that water suppliers must comply with. This requires the use of water treatment in some areas to ensure that drinking water supplied is acceptable.
Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources	• The objectives of the directive are to ensure that the nitrate concentration in freshwater and groundwater supplies does not exceed the limit of 50 mg NO_3- per litre as imposed by the EU Drinking Water Directive (above) and to control the incidence of eutrophication. • Having set the overall targets, the directive requires individual Member States to draw up their own plans for meeting them, including: Drawing up a Code of Good Agricultural Practice Designating zones vulnerable to pollution by nitrates Establishing and implementing Action Programmes within these zones to prevent further nitrate pollution
Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive)	• The Water Framework Directive (WFD) has the overall environmental objective of achieving 'good water status' throughout the EU by 2010 and for it to be maintained thereafter. It sets out to establish a Community framework for the protection of surface and ground waters across the EU through a common approach, objectives, principals and basic measures. • The WFD establishes the river basin as the primary administrative unit for the purposes of water management. The Directive will have widespread and significant impacts. It brings together much of the existing water legislation into an overall framework establishing broad ecological objectives for water and provides an administrative framework to achieve these. • This Directive places no direct obligation on farmers, but they influence the standards that must be met by them.

Of these, only the Nitrate Directive 91/676 currently places any direct obligation upon farmers and for over a decade has effectively promoted a variety of good practices for reducing diffuse nitrate pollution by nitrates through a variety of good agricultural practices, including good practices in fertiliser and manure application.

The objectives of the Directive are two-fold: i) to reduce water pollution caused or induced by nitrates from agricultural sources and; ii) to prevent further pollution occurring. The Directive requires EU Member States to identify waters affected by nitrate pollution (as well as waters which could be affected) and to designate the areas draining into these as Vulnerable Zones. Within these zones, the Member States must draw up Action Programmes for the reduction of nitrate leaching – these Action Programmes must contain certain mandatory measures such as limit upon the maximum amounts of manure that can be applied to farmland every year.

Member States are also required to establish at least one *Code of Good Agricultural Practice* which is implemented on a voluntary basis outside the Vulnerable Zones, and is mandatory within them. Annex II of the Nitrate Directive, provides guidance on what a code of good agricultural practice should contain. It requires that all codes *should* contain measures (where relevant) addressing 6 key issues:

1. periods when land application of fertilizer is inappropriate
2. the land application of fertilizer on steeply sloping ground
3. the land application of fertilizer on water-saturated ground, flooded, frozen or snow-covered ground
4. the land application of fertiliser near water courses
5. the capacity and construction of storage vessels for livestock manures and other liquid farm wastes, such as effluent from silage
6. procedures for the land application (including rate and uniformity) of both chemical fertilizer and animal manure that will maintain nutrient losses to water to an acceptable level

Additionally, the Directive suggests that Member States *may* also include in their code(s) of good agricultural practice additional measures that address the following 4 issues:

7. land use management, including the use of crop rotation systems and the proportion of the land area devoted to permanent crops relative to annual tillage crops
8. maintenance of minimum quantity of vegetation cover during rainy periods that will take up the nitrogen from the soil that could otherwise cause nitrate pollution of water
9. the establishment of fertilizer plans on a farm-by-farm basis and the keeping of records on fertilizer use
10. the prevention of water pollution from run-off and downward water movement beyond the reach of crop roots in irrigation systems.

Unfortunately, the Nitrates Directive has consistently failed to meet its environmental objectives and has suffered from both considerable resistance by the EU agricultural community and poor implementation by many Member States[12]. One problem has been the lack of appropriate tools – particularly economic instruments - to support implementation of the Directive. For example, Member States have not been able to offer farmers agri-environment payments to encourage them to meet the obligatory reductions in fertiliser application required in designated "nitrate vulnerable zones" under the Nitrate Directive because EU rules currently prevent agri-environment payments being made to farmers for complying with the requirements of EU legislation.

It is now hoped that similar rules will not be applied to implementation of the Water Framework Directive 2000/60 since this will significantly limit its ability to promote the use of economic instruments available under the CAP to reduce the risk of nutrient losses from agricultural land and promote the improvement of water quality.

[12] European Commission (2002). Implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources: Synthesis from year 2000 Member States reports. Report No. COM(2002) 407 final, Brussels, 17.07.2002

Opportunities for Implementing the Water Framework Directive

The Water Framework Directive (WFD) was adopted in December 2000 and arises out of a long debate concerning the limitations of existing EU water legislation – the existing body of legislation was criticised for being too fragmented, concentrating on specific aspects of environmental quality or specific threats to that quality.

The Directive requires that surface waters (rivers, lakes and coastal waters) and ground waters are to be managed within the context of River Basin Management Plans[13]. All waters are to be characterised according to their biological, chemical and hydro-morphological characteristics. These together are to be compared with an assessment of waters unmodified by human activity and classified into different categories of ecological status. All waters are required to meet 'good status', except where specific derogations are applied.

The means to achieve this is through the use of the River Basin Management Plans which should integrate existing EU measures to protect the water environment and identify all remaining human pressures which may result in a failure to achieve 'good status'[14]. Member States are required to establish a programme of measures in each river basin appropriate to these pressures.

There is now considerable debate within many Member States on what the implications of the WFD will mean for agriculture - in particular, how the Member States (including the 10 new Member States joining the EU in 2004) will use appropriate policy instruments to tackle the significant pressures upon water resources that arise from agriculture, including the risk of pollution. A potential problem in many Member States is that unlike other sectors, regulation of the agricultural sector is highly politically sensitive – a situation that arises and results from a range of socio-political and cultural factors. Many governments have therefore tended to avoid the simple imposition of environmental conditions upon farmers – even basic conditions which they would otherwise readily apply, for example, to heavy industry.

The WFD requires that Member States now address this issue and consequently there is much interest in using the policy tools available in the Common Agricultural Policy (CAP) to support and implement the WFD[15], including:

- **CAP Pillar 1 – Market Support Measures** – according to the revised 'Common Rules' Regulation (No. 1782/2003)[16], it will be **obligatory** for all Member States to include specific environmental requirements as a condition for farmers receiving direct support payments from the government (so-called "cross compliance"). Member States were previously reluctant to voluntarily use this policy instrument, but it could now be used for numerous aspects of water pollution control
- **CAP Pillar 2 - Rural Development Measures** – EU co-financed rural development programmes provide funding for several measures that support farmers, rural communities and protection of the natural environment. Some of these measures could directly contribute to the implementation of the WFD and the reduction of agricultural water pollution, particularly "investment in agricultural holdings", "training" and "agri-environment measures"

Of all the tools of the CAP, agri-environment measures seem the most useful for supporting implementation of the WFD – however, EC rules currently prevent agri-environment payments being made to farmers for complying with the requirements of EC legislation. For example, farmers cannot be offered support payments to encourage them to meet the obligatory reductions in fertiliser application required in designated "nitrate vulnerable zones" by the Nitrate Directive. If this rule is also extended to the WFD then it will significantly limit the use of CAP Pillar 2 funding for

[13] Bloch, H. (2000). EU policy on nutrients emissions: legislation and implementation. In: *Wastewater and EU-Nutrient Guidelines*, pp 52-59. International Water Association, London.

[14] Griffiths, M. (2002). The European water framework Directive: an approach to integrated river basin management. *European Water Management Online*, 2002.

[15] DG Environment (2003) - Working Document on The Water Framework Directive (WFD) and tools within the Common Agricultural Policy (CAP) to support its implementation

[16] Council Regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers

encouraging farmers to the wide range of actions on water pollution that are necessary to achieve good ecological status, etc.

No decisions have been made in relation to this issue yet. However, early indications from DG Environment suggest that it would not seek to restrict payments under agri-environment for implementing the WFD as has been done for the Nitrates Directive.

Financial Incentives for Pollution Control

As mentioned above, the EU Rural Development Regulation 1257/1999 (the "second pillar" of the CAP) makes provision for Member States to encourage more environmentally-friendly farming methods, including practices and actions that reduce the risk of agricultural pollution. This offers a good opportunity for supporting the control of nutrient pollution in those DRB countries joining the EU, by allowing them to develop EU co-financed schemes that:

d) offer grant-aided investment (up to 50%) in agricultural holdings that helps to *"...preserve and improve the natural environment"* – for example, by purchasing new manure storage facilities or purchasing more up-to-date equipment for fertiliser and manure application

e) training farmers for the *"...application of production practices compatible with the maintenance and enhancement of the landscape and the protection of the environment"* – this includes:
   - training for organic farming
   - training for farming management practices with a specific environmental protection objective

f) introducing agri-environment schemes that offer area payments to support *"...agricultural production methods designed to protect the environment and to maintain the countryside"* – this is very important tool for supporting the adoption of organic farming, as well other pollution control techniques such as uncultivated buffer strips, conversion of arable to pasture land and the introduction of more diverse crop rotations.

EU Member States began implementing the first so-called "agri-environment programmes" in the 1980s and 1990s, and today such programmes cover over 20% of all agricultural land in the EU. These programmes pay farmers to modify their farming practices in order to benefit the environment.

Extensive monitoring of agri-environment programmes in EU Member States shows that they lead to significant benefits for the conservation of valuable semi-natural habitats, biodiversity, landscape, water and soil resources. The potential for agri-environment schemes to contribute to a wide range of rural development objectives, including environmental protection, is recognised by the fact that they are now the **only** compulsory measures for EU Member States to introduce under Regulation 1257/1999.

It will therefore be obligatory upon accession for all new Member States to introduce an EU co-financed agri-environment scheme that offers payments to farmers who change their methods of farming in ways *"...which are compatible with the protection and improvement of the environment, the landscape and its features, natural resources, the soil and genetic diversity"* – this includes support for a range of actions contributing to the control of pesticide pollution, including the adoption of organic farming.

While the four DRB countries (Czech Republic, Slovakia, Hungary and Slovenia) joining the EU in 2004 will shortly be implementing national agri-environment programmes, two DRB countries (Romania and Bulgaria) are unlikely to join the EU until at least 2007. In these latter countries, financial assistance is also available for developing and implementing "pilot" agri-environment measures with SAPARD co-funding – the Special Pre-accession Programme for Agriculture and Rural Development.

Co-funding will be available for several years for similar measures to be developed and implemented in Romania and Bulgaria under the SAPARD programme – the Special Pre-accession Programme for Agriculture and Rural Development. According to the SAPARD Implementing Regulation No. 1268/1999, EU co-financing support may be provided for all the agri-environment actions described in the Rural Development Regulation No. 1257/1999.

Additionally, following agreement on proposals arising from the recent Mid-term Review of the CAP a new "meeting EU standards" measure will be introduced to "*help farmers adapt to the introduction of demanding standards based on EU legislation…concerning the environment, public, animal and plant health, animal welfare and occupational safety*". This is potentially a very useful tool for reducing pollution and some of the acceding countries are proposing to make extensive use of it to improve manure storage and management facilities on farms.

Developing the EU Concept of "Cross Compliance"

The concept of cross-compliance in agriculture (setting conditions which farmers have to meet in order to be eligible for direct government support) has been growing in importance since the 1970s. After many years of debate it is now also seen as an important policy tool in the EU to help improve standards in farming and protect the environment.

The "Agenda 2000" reform of the CAP introduced cross-compliance for the first time as a key policy instrument for improving the environmental performance of farmers in the EU by:

c) allowing Member States to attach environmental conditions to the so-called 'First Pillar' of the CAP, and;
d) requiring Member States to define verifiable standards of Good Farming Practice (GFP) for farmers to follow before they could certain receive funds under the Rural Development Regulation (No. 1257/1999) - the so-called 'Second Pillar' of the CAP.

Member States showed relatively little interest in the option for voluntary cross-compliance introduced in the original "Agenda 2000" CAP reform. In most countries it was not adopted at all, in others it appears only to have been used to address very specific environmental problems e.g. limits on pesticide use in maize in the Netherlands.

The June 2003 Mid-term CAP reform package however now **obliges** all Member States to have a system of cross compliance in place for all direct support schemes from January 2005 in accordance with the revised 'Common Rules' Regulation 1782/2003[17].

"First Pillar" Cross Compliance

Discussions are currently underway in Member States on how to implement the new obligations for "first pillar" cross compliance which require that the full payment of direct support schemes under the CAP must be linked to compliance with rules relating to the management of agricultural land and production activities.

Most Member States have not yet (December 2003) established a formal position or initiated consultations on "first pillar" cross compliance, but are waiting for clearer guidance from the European Commission in the form of an Implementing Regulation (this is not expected until spring 2004). However, it is clear from Regulation 1782/2003 that there are two general obligations upon Member States:

A. Statutory Management Requirements

There are a total of 18 Directives listed in Annex III of Regulation 1782/2003 on the environment, public, plant and animal health and animal welfare. Member States are required to ensure that all farmers receive a list of statutory management requirements for fulfilling obligations under these Directives. Eight of these Directives have to be implemented from 1 January 2005[18], a further seven from 1 January 2006 and the remainder from 1 January 2007. This will require the development of appropriate verifiable standards, as well on-the-spot checks to ensure compliance with the management requirements.

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[17] Council Regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers

[18] Those relating to the environment are Directives 79/409/79 on conservation of wild birds, 80/68/79 on protection of groundwater, 86/278/86 on sewage sludge, 91/676/91 on nitrates and 92/43/92 on conservation of habitats

B. Good Agricultural and Environmental Condition

Annex IV of the revised Common Rules Regulation requires Member States to ensure that land is maintained in good agricultural and environmental condition, especially land no longer used for production purposes. Member States must decide how they will define Good Agricultural and Environmental Condition (GAEC) as set out in Annex IV. Appropriate standards can be set for maintaining GAEC at national or regional level, and must take into 'account 'the specific characteristics of the areas concerned, including soil and climatic condition, existing farming systems, land use, crop rotation, farming practices, and farm structures'.

Various approaches to the implementation of obligatory cross-compliance are expected, since Member States have considerable subsidiarity on many aspects. Although most Member States will probably only require farmers to meet minimum standards set out in the Regulation, it is again expected that some will use this as an opportunity to raise standards in agriculture and may go beyond EU standards.

"Second Pillar" Cross Compliance

Another useful tool will be the "verifiable standards of Good Farming Practice (GFP)" that all farmers receiving payments from agri-environment and less-favoured area schemes funded by the Rural Development Regulation - the so-called CAP 'Second Pillar' - must comply with across the whole of their farm[19].

Good Farming Practice (GFP) is a relatively new concept to emerge within the EU and its practical implementation is still being tested in many Member States. Obviously the interpretation of what constitutes a "reasonable" standard of farming will vary from country to country, however it is generally assumed that it will consistently involve farmers:

- following relevant existing environmental legislation, and;
- not deliberately damaging or destroying environmental assets, including the pollution of watercourses.

It should be noted that GFP is **not** equivalent to the Code of Good Agricultural Practice (CoGAP) that Member States must introduce in accordance with the requirements of the EU Nitrates Directive 676/91.

GFP is likely to become an even more important element of agricultural policy in future and is very relevant to the concept of Best Agricultural Practice promoted by the ICPDR. However, the verifiable standards of GFP prepared by Member States do vary considerably since there are currently no detailed requirements for the establishment of GFP standards and no common baseline exists across the EU.

On-farm Quality Assurance Schemes

There is increasing interest shown by farmers, the food industry and food retailers in EU Member States to establish "on-farm quality assurance schemes" that offer consumers the assurance of food products having been grown with reduced or minimal pesticide inputs.

The most developed example is organic farming as defined by EC Regulation 2092/91. Organic farming has the highest potential for reducing the use of toxic pesticides. Many organic crops are grown without the use of any pesticide, and the former intense use of copper in organic fruits and vineyards is now regulated.

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[19] Under Section 9 of EC Regulation No. 1750/1999, which sets out the rules for several measures including agri-environment, it is stated that: *"Usual good farming practice is the standard of farming which a reasonable farmer would follow in the region concerned.....Member states shall set out verifiable standards in their rural development plans. In any case, these standards shall entail compliance with general mandatory environmental requirements."*

In addition, a number of other quality assurance schemes are being developed which are based upon "integrated crop management". For example, the Euro-Retailer Produce Working Group (EUREP) has developed a set of standards and procedures for inspecting and certifying farmers who follow so-called "good agricultural practice" (GAP).

The EUREP-GAP initiative[20] is a set of normative documents suitable to be accredited to international certification laws. Representatives from around the globe and all stages of the food chain have been involved in the development of these documents and a very robust, very challenging protocol has been produced which focuses the producer on the key issues that need to be addressed during the pre-farm gate stage. Table 6 below summarises the mandatory requirements relating to fertiliser usage for farmers and growers complying with EUREP-GAP Fresh Produce Protocol.

Table 6: Mandatory Requirements Relating to Fertiliser Usage in the EUREP-GAP Fresh Produce Protocol

Nutrient Requirement • Fertiliser application, using either mineral or organic fertilisers, **must** meet the needs of the crops as well as maintaining soil fertility.
Advice on Quantity and Type of Fertiliser • Growers or their advisers **must** be able to demonstrate competence and knowledge.
Records of Application • All applications of soil and foliar fertilisers **must** be recorded in a crop diary or equivalent. Records **must** include: location, date of application, type and quantity of fertiliser applied, the method of application, and operator.
Timing and Frequency of Application • Any application of fertilisers in excess of national or international limits **must** be avoided.
Nitrate and Phosphate Levels in Ground Water • It is the **responsibility** of growers or grower organisations to ensure that the usage of fertilisers does not result in nitrate or phosphate enrichment of groundwater in excess of national and international limits.
Application Machinery • Fertiliser application machinery **must** be suitable for use on the land in question and be kept in good condition, with annual calibration to ensure accurate delivery of the required quantity of fertiliser.
Fertiliser Storage • Fertilisers **must** be stored appropriately. • Fertilisers **must** be stored covered in a clean, dry location where there is no risk of contamination of water sources. • Fertilisers **must** not be stored with nursery stock or fresh produce. • All hazard and risk areas **must** be clearly indicated.

20 EUREP website: www.eurep.org/sites/index_e.html.

"Good Practice" for Improving the Management of Fertilisers and Manures

In order to reduce the risk of diffuse pollution by nutrients (N and P) from agriculture it is necessary to encourage practical farm management techniques that minimise the opportunities for nutrients to accumulate in a form that is susceptible to loss.

By using current and evolving scientific knowledge it is possible to develop simple practical guidelines for the management of the nutrient inputs most commonly used by farmers – namely mineral fertilisers and manures. These should be applicable to all farmers at little or no cost thereby minimising the need for financial incentives – furthermore, it should always be stressed to farmers that improvements in nutrient management also means improvements in productivity, cost-effectiveness and ultimately profit.

The following typical management practices are commonly promoted to reduce the risk of nitrate leaching (especially during periods of high risk, such as the autumn and winter months):

10. Ensure that fertiliser N is applied according to the crop's requirement and taking account of:
    - the crop species/variety, expected yield and required quality
    - the natural supply of N from the soil, including N released from soil organic matter, crop residues and applied manure/slurry
11. Avoid applications of N fertilisers and manure/slurry in autumn and very early spring when crop requirements for N are very low
12. Limit the application rate of organic manure/slurry to ensure that N supply does not exceed crop requirements – this includes applying in smaller quantities at regular intervals to match more closely the crops requirement for nutrients during the growing season
13. Take special care when applying fertilisers and manure/slurry on fields where there is a risk of run-off to surface waters
14. When applying fertilizers/manures, ensure that an adequate distance (a "buffer zone") is kept away from surface waters to avoid the risk of direct pollution
15. Ensure accurate calibration of fertiliser spreading equipment to minimise the risk of excessive application
16. Minimise the period when the soil is left bare and susceptible to nitrate leaching by increasing the area sown to winter crops, cover crops and grassland, whilst decreasing the areas sown to spring crops
17. Sow winter crops early in the autumn to increase nitrate uptake prior to the onset of the winter leaching period
18. Restrict the ploughing of old grassland.since this leads to excessive amounts of nitrate being produced by the natural process of mineralisation and commonly leads to high levels of nitrate leaching

It must be remembered, however, that diffuse nutrient losses from agriculture are greatly influenced by climate, soil type, cropping system and the forms and quantity of fertiliser and manure applied. Additionally diffuse losses of P are influenced by factors such as the vulnerability of soil to erosion. The typical management practices outlined above must therefore always be elaborated and expanded upon according to different national – and ideally regional/local – contexts.

Technological and scientific developments will also play a major role in continuing to improve the efficiency of nutrient use in agriculture – for example, the use of high technology for targeting fertiliser inputs in cereal production through the use of so-called "precision farming techniques" offers considerable opportunity to both improve the efficiency and profitability of fertiliser use, as well further reduce nutrient losses. But for the moment such technology remains very capital intensive and beyond the reach of most farmers.

The important thing is to ensure that the practical guidance developed for "good practice" is flexible and pragmatic – this is likely to involve the combination of both new technologies and more traditional nutrient conserving techniques such as those outlined above.

Recommendations for Policy Reform in DRB Countries

Despite the relatively low levels (compared to many EU Member States) of mineral fertiliser and manure currently applied to agricultural land in the central and lower DRB region, national governments should take seriously the risk of diffuse pollution arising from fertiliser and manure application.

The following objectives relating to fertiliser and manure application are recommended for all national strategies aiming to control nutrient pollution from agriculture. Comments are also included on policy instruments that should be adopted **where appropriate to national context[21]:**

OBJECTIVE 1: Develop greater understanding at a national/regional level of the relationship between agricultural practice (fertiliser, manure and land management) and the risk of diffuse nutrient pollution

1.2 **Establish progressive and well-funded research programmes** – whilst scientific understanding of nutrient losses from agricultural land and the related transport processes to ground and surface waters has increased in recent years this cannot be applied uniformly across the DRB for the development of good/best practice. Country/regional specific guidance for farmers must be based upon an understanding of the behaviour of nutrients in the specific agronomic, environmental and socio-economic context of each country. For example:

- the nutrient content of animal manures need to be quantified to aid more precise application
- the nutrient losses from different components of the farm system to be measures and the causes of these losses established
- the underlying soil processes affecting nutrient availability (e.g. soil mineralisation) need to be better understood

OBJECTIVE 2: Develop appropriate policy instruments and institutional arrangements for promoting better management of fertilisers and manures

2.5 **Raise Farmer Awareness of Good Practice** - simple and easy to understand information materials, combined with well-targeted publicity campaigns, can be very effective at raising farmers' awareness of the importance of improving the management of fertilisers and manures – a key message to communicate is that better nutrient management increases productivity, saves money and improves profitability.

2.6 **Develop and Promote National Codes of Good Practice** – national authorities should agree upon clear and simple codes of voluntary good practice for fertiliser and manure management. This should be specific to national context and ideally linked to/derived from progressive and well-funded research programme (see 1.1 above)

2.7 **Use Economic Instruments to Promote Good Practice** – where government schemes are providing support to farmers then the principle of "environmental cross-compliance" can be applied. This involves the establishment of certain conditions that farmers have to meet in order to be eligible to receive government support and can easily be adapted to the promotion of good practice for fertiliser and manure management. Additionally, payments to farmers from agri-environment schemes (where implemented) can be conditional upon certain standards for fertiliser and manure management. Appropriate financial disincentives might also be developed.

[21] Not all policy instruments are appropriate to all countries

2.8 **Develop Appropriate Extension Capacity** – agricultural extension services play a key role in raising awareness and improving the technical skills of farmers with respect to good practice for fertiliser and manure management, however they often require support in developing the necessary capacity to do this. National funding should be provided for the training of advisers in good practice and modern extension techniques, as well as the development of appropriate institutional frameworks for extension services (including the link to progressive and well-funded research programmes – see 1.1 above)

OBJECTIVE 3: Promote certified organic farming and other low input farming systems as viable alternatives to the conventional use of fertilisers

3.5 **Raise Farmer Awareness** – alternative farming systems, such as organic farming, should be actively promoted to farmers through the preparation of simple and easy to understand information materials. Organic farming is the most well-developed of all alternative farming systems and has good potential to reduce nutrient losses through the avoidance of the most soluble forms of mineral fertiliser, more rational use of manures and use of more diverse crop rotations (e.g. increased winter crop cover) - whilst also contributing to the reduction of pesticide pollution etc.

3.6 **Develop Relevant Legislation –** national legislation for the certification and inspection of organic farming systems in compliance with internationally recognised standards (particularly those in accordance with EC legislation) should be developed and implemented as a high priority in order to promote the development of domestic markets and international trade

3.7 **Develop Appropriate Extension Capacity** – agricultural extension services and farm advisers play a fundamental role in the re-orientation of farmers towards alternative production systems, particularly those such as organic farming, which require higher levels of technical knowledge and management. National funding should be provided for the development of appropriate extension capacity as 2.4 above

3.8 **Use Economic Instruments to Promote Organic Farming** – farmers converting to organic farming techniques can incur certain additional costs associated with reductions in input, establishment of new crop rotations, adoption of new technologies etc. These costs can be a significant obstacle to farmers deciding making the transition from a conventional farming system. Where funds are available, national authorities should encourage farmers to convert to organic farming by offering appropriate levels of compensatory payment. Since organic farmers often have problems to sell or export their products, the marketing of organically-grown products should also be supported by governmental campaigns and action.

Annexes

Annex 1

Review of the Use of Mineral Fertiliser Products in the DBR (Questionnaire)

Annex 1: Review of the Use of Mineral Fertiliser Products in the DRB Countries (Questionnaire)

Step 1 – Types of N and P Fertiliser Commonly Used by Farmers

Please identify the types of mineral fertiliser (including the nutrient-containing chemicals and materials) that are commonly used by in agriculture and horticulture by completing the boxes in the tables below.

I make the distinction between the use of so-called **straight fertilisers** that include a single nutrient-containing chemical and **compound (NPK) fertilisers** that include chemicals or mixtures of chemicals that contain more than one nutrient

If you have any comments upon the importance of particular fertiliser types, trends in use etc please add them to the final column

Type of Fertiliser	Used by Farmers - Yes/No?	Typical Nutrient-containing Chemicals	Yes/ No?	Typical Formulation (N:P:K)	Comments
N FERTILISERS					
Straight N Fertilisers		Ammonium sulphate		Not applicable	
		Ammonium nitrate			
		Calcium nitrate			
		Urea			
		Anhydrous ammonia			
		Aqueous ammonia			
		Other – please specify			
Compound Fertilisers		Mono-ammonium phosphate			
		Di-ammonium phosphate			
		Other – please specify			

avalon

GFA terra systems

Type of Fertiliser	Used by Farmers - Yes/No?	Typical Nutrient-containing Chemicals	Yes/ No?	Typical Formulation (N:P:K)	Comments
P FERTILISERS					
Straight P Fertilisers		Rock phosphate		Not Applicable	
		Triple superphosphate			
		Other – please specify			
Compound Fertilisers		Mono-ammonium phosphate			
		Di-ammonium phosphate			
		Other – please specify			

Step 2 – Total Consumption of N and P Fertiliser by Farmers

Please complete the following table with as much national data as possible on the total use of mineral fertilisers by farmers in your country for the years 1997 - 2002. Please ensure that the data you use for the quantity of fertilisers used and applied is the **amount of nutrient** (N or P) not the amount of fertiliser product/chemical (for example, 1 tonne of ammonium nitrate contains only 345 kg of nitrogen)

		Year						
		1997	1998	1999	2000	2001	2002(?)	Source of data
N FERTILISERS	Total N consumption (tonnes)							
	Total agricultural area treated with N fertilisers ('000s ha)							
P FERTILISERS	Total N consumption (tonnes)							
	Total agricultural area treated with P fertilisers ('000s ha)							

Step 3 – Characteristics of N and P Fertiliser Use by Farmers

The data on national sales collected above is very important, but the environmental impact of mineral fertiliser use is related closely to the way in which farmers apply fertilisers to their crops. Please help us to understand more about how farmers are **currently** using mineral fertilisers in your country by completing the following table as fully as possible – this is organised according to main crop type and includes:

1. approximately what **percentage of the crops grown** currently have mineral fertilisers applied to them – if no crops are have fertilisers applied because of the current economic situation, for example, please clearly state this in the final column under Comments

2. the current **average or "typical" application rate** (kg per ha) for N and P fertilisers – again please ensure this is the **amount of nutrient** (N or P) applied not the amount of fertiliser product/chemical. If the application rates vary greatly according to the crop, please clearly state this and include the range of application rates (e.g. 30 - 70 kg N per ha according to the crop variety being grown)

3. the **typical time of fertiliser application** (e.g. in autumn or spring when planting) – this is particularly important regarding the application of N fertilisers

Please feel free to add any additional comments to the final column, such as trends in fertiliser use etc

	N FERTILISERS			P FERTILISERS		
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**	**Comments**
Wheat, barley etc						
Maize						
Sunflower						
Sugar beet						
Tobacco						
Potatoes						
Field vegetables (except potatoes)						
Glasshouse vegetables						
Orchards						
Vineyards						
Pasture and other grassland						
Others – please specify						

Step 4 - Known "Bad Practice" Regarding the Use of Mineral Fertilisers

Next - we would like you to identify any "bad practice" associated with the use of mineral fertilisers by farmers in your country - for example, this might include:

- using application rates that are higher than recommended rates (unlikely in many countries)
- poor application due to old or poorly maintained equipment
- spreading too closely to water sources e.g. streams and rivers
- applying mineral fertiliser at an inappropriate time of year (i.e. when the crop is not growing)

It would be useful to know where this information about bad practice comes from – is it the professional knowledge of yourself or other experts? Is it actually the common practice amongst farmers? Was it reported in a farming journal or a report? **Please do not hesitate to be honest about these things – it is very important information for us to collect**

The table below is organised according to crop, but if you have only general comments to use please delete these crops (or if you have more specific comments to make, please add more crops)

Crops	Known Bad Practice by Farmers	Source of Information
Wheat, barley etc		
Maize		
Sunflower		
Sugar beet		
Tobacco		
Potatoes		
Field vegetables (except potatoes)		
Glasshouse vegetables		
Orchards		
Vineyards		
Pasture and other grassland		
Others		

Annex 2

Bosnia & Herzegovina

Annex 2: Bosnia & Herzegovina

Types of N and P Fertiliser Commonly Used by Farmers in the Republic of Srpska

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
N FERTILISERS			
Straight N Fertilisers	Ammonium sulphate		Relative high use in relation to the total quantity of single N fertilisers.
	Ammonium nitrate		As above
	Calcium nitrate		
	Urea		The largest use in relation to single N fertilisers.
	Anhydrous ammonia		
	Aqueous ammonia		
	Calcium ammonium nitrate KAN		High use in relation to total quantity N fertilisers.
	Mixture of urea and ammonium nitrates in aqueous or ammonia form.		High use with trend of increase.
	Mixture of calcium nitrate & ammonium nitrate.		Low level of use.
	Sodium nitrate/Calcium nitrate		Low level of use.
	Ammonium chloride		Low level of use.
Compound Fertilisers	Mono-ammonium phosphate	-	Low level of use with trend of decrease
	Di-ammonium phosphate	-	Low level of use with trend of decrease
	Nitrophosphates	-	Insignificant use
P FERTILISERS			
Straight P Fertilisers	Rock phosphate		Low level of use
	Triple superphosphate		The largest use of P fertilisers, but it is still low
	Calcine phosphates		Noted very low use (consumption)
	Thomas's flour		Very low rate of use
Compound Fertilisers	Mono-ammonium phosphate	-	Low level of use with trend of decrease
	Di-ammonium phosphate	-	Low level of use with trend of decrease
	Nitrophosphates	-	Insignificant use

Total Consumption of N and P Fertiliser by Farmers in the Republic of Srpska

		Year						
		1997	1998	1999	2000	2001	2002(?)	Source of data
N FERTILISERS	Total N consumption (tonnes)	756*	977*	1,280*	9,212	17,971	20,138	Institute for Statistics of RS , Customs Administration of RS
	Total agricultural area treated with N fertilisers (‘000s ha)	19	20	16	405	389	360	Institute for Statistics of RS
P FERTILISERS	Total P consumption (tonnes)	315*	348*	488*	3,562	7,455	6,204	Institute for Statistics of RS, Customs Administration of RS
	Total agricultural area treated with P fertilisers (‘000s ha)	19	20	16	405	389	360	Institute for Statistics of RS

* Years: 1997, 1998 and 1999 - these data are related to public sector ***only*** (i.e. ***STATE FARMS***) (Source: Institute for Statistics of RS).
The data for: 2000, 2001 and 2002 years are related to the total land under cultivation (arable land), that means and **individual** *and* **public** sector.

Characteristics of N and P Fertiliser Use by Farmers in Republic of Srpska

	N FERTILISERS			P FERTILISERS		
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**TypicalTiming of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**	**Comments**
Wheat	50-60	95	Autumn (during seeding) and Spring (top- dressing)	50-60	45	About 70,000 ha are under wheat in RS.These application rates (norms) are related to good producers. Farmers mostly have not money to acquire adequate quantities of fertilisers. For start fertilisation (during soil cultivation-preparation for planting) NPK fertilisers are used, mostly 15-15-15, or similar formulation. For top-dressing KAN is used (somewhere UREA).
Barley	50	90	Spring	50	45	The smaller areas in the higher altitudes are under barley. Some farmers are used mineral fertilisers, but most of them are used the manure, without fertilisers.

	N FERTILISERS			P FERTILISERS		
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**TypicalTiming of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**	**Comments**
Oats	40	90	Spring	40	45	Mostly in hilly-mountain areaa, without top- dressing and with manure application. Left mentioned application rates are for better producers only.
Maize	70	120	During seeding and top-dressing	70	45	Maize is crop on the first place in RS regarding seeded area (140,000-160,000 ha). NPK fertilisers, mostly 300 kg of 15-15-15 formulation/haare using for fertilisation, during soli cultivation and seeding + 1X top-dressing, with CaAN=KAN (80% of producers) and urea (20% of producers) fertilisers. Such situation applied 70% of farmers. 30 of them applied full quantity of fertilisers before and during the seeding and 70%. About 30% of farmers are used manure (before ploughing) + NPK fertilisers (during the seeding) for maize fertilisation (without top-dressing).
Soyabean	70	45	Before seeding or in autumn before ploughing	70	45	Before sowing or in autumn **before ploughing**
Tobacco	80	20	Before seeding and top-dressing	80	60	For fertilisation super phosphates are used and for top-seeding compound (complex) fertilisers.
Potatoes	60	180	All before planting	60	100	Farmers are used NPK 10-20-30, 15-15-15 and urea fertilisers mostly. In hilly-mountain regions they are using manure without mineral fertilisers application.
Field vegetables (Tomato and pepper)	70	190	Before ploughing, before planting and top-dressing	70	125	Farmers are used NPK formulations: 7-20-30, 15-15-15, and urea, CaAN=KAN. If they are using manure, application rates are about 20-30 t/ha
Orchards	60	95	Two application February-March, and top-dressing after blooming (flowering)	60	50	These application rates of fertilisers are related to farmers with extensive fruit production, which is dominant now in BIH. Only small areas are under intensive production where farmers are using about 130 kg N/ha about 100 kg P/ha, and sometimes 10-20% more.
Pasture and Forage	40	50-80	Top-dressing			Mainly for top-dressing, after mowing tha grass (2-3 times with CaAN=KAN or urea fertilisers)

Known "Bad Practice" by Farmers Regarding Nutrient Management in the Republic of Srpska

Crops	Known Bad Practice by Farmers	Source of Information
Wheat, barley etc	Erosion is increased by irregular cultivation on slopes. Insufficient use of manure and fertilisers. Uneducated farmers. Application of manure into a dry soil where NH_4 evaporate. The main problem is old and uncompleted mechanical equipment.	M.Sc. Milos Nozinic, Agricultural institute, Banja Luka, Dept. for cereals
Maize	Wrong time of application, bad quality of cultivation, insufficient quantity of manure, bad and insufficient mechanical equipment. An example of BAD Agr Practice is state farm "Mladen Stojanovic, Nova Toplola, near Vrbas river, between Banja Luka and Gradiska, where during last autumn and this spring they cultivated and fertilised about 100,000-200,000 ha, **but not planted** (unsatisfied workers-this is on some way their protes against poor relation of society and government to their position).	M.Sc. Slavko Radanovic Maize department, Agricultural institute, Banja Luka
Soybean	Bad application because lack of appropriate mechanisation and inappropriate time of fertilisers application.	Slobodanka Markovic, B.Sc. State Farm "Semberija" Bijeljina.
Tobacco	Lack of manure, that is very effective in tobacco production.	Own experience.
Potatoes	In some production areas farmers are applyied too big application rates (doses) of mineral fertilisers (e.g. in Lijevce polje, near Vrbas river, about 1000 kg NPK before seeding and 400 kg urea for top-dressing).	Spremo Drago, B.Sc., Agricultural institute, Banja Luka
Field vegetables (except potatoes)	Mineral fertilisers application rates which are using farmers in Lijevce polje are without the results of earlier soil analyses (approximate). Lack of organic fertilisers, and than using high doses of mineral fertilisers.	M.Sc. Vida Todorovic-Mitric. Faculty of agriculture, Banja Luka
Orchards	Late application of NPK. Application of fertilisers on soil surface, without incorporation. Application of inappropriate NPK formulations.	M.Sci. Rados Ljubomir Agricultural institute Banja Luka

Types of N and P Fertiliser Commonly Used by Farmers in the Federation of Bosnia & Herzegovina

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
N FERTILISERS			
Straight N Fertilisers	Ammonium sulphate	$(NH4)_2SO_4$, 21% N	Very low*
	Calcium nitrate	$Ca(NO_3)_2$, 15 % N	Very low*
	Urea	$CO(NH_2)_2$, 46 % N	About 40 %
	Calcium ammonium nitrate KAN	NH_4NO_3 x $CaCO_3$ 27 % N	About 45%
	Mixture of urea + ammonium nitrates + water (UAN)	30% N	Very little*
	Liquids N-fertilizers		Very little for plastic and green houses, vegetable and flower production*
Compound Fertilisers	Mono-ammonium phosphate MAP	$NH_4H_2PO_4$ 12 % N 52 % P_2O_5	Very little*
	Di-ammonium phosphate DAP	$(NH_4)_2HPO_4$!8 % N 46 % P_2O_5	10 % Usages are increasing every year

* Total amount of the nitrogen from this sources is about 5%

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
P FERTILISERS			
Straight P Fertilisers	-		
Compound Fertilisers	Mono-ammonium phosphate MAP	$NH_4H_2PO_4$ - 12 % N, 52 % P_2O_5	Very little
	Di-ammonium phosphate DAP	$(NH_4)_2HPO_4$ - !8 % N, 46 % P_2O_5	Usages are increasing every years.

Total Consumption of N and P Fertiliser by Farmers in the Federation of Bosnia & Herzegovina

		Year						
		1997	1998	1999	2000	2001	2002(?)	Source of data
N FERTILISERS	Total N consumption (tonnes)	6.066	9.963	11.826	30.315,31	22.207,12	10.292,04	Federal Ministry for Agriculture Custom office
	Total agricultural area treated with N fertilisers ('000s ha)	766	787	784	729	614	605	Federal Statistics biro
P FERTILISERS	Total N consumption (tonnes)	2.729	5.011	4.570	3.428,83	2.410,16	1.193	Federal Ministry for Agriculture Custom office
	Total agricultural area treated with P fertilisers ('000s ha)	766	787	784	729	614	605	Federal Statistics biro

Characteristics of N and P Fertiliser Use by Farmers in Federation of Bosnia & Herzegovina

	N FERTILISERS			P FERTILISERS		
Crop	% Crop Receiving N Fertiliser	Typical Application Rate (kg N/ha)	Typical Timing of Application	% Crop Receiving P Fertiliser	Typical Application Rate (kg P_2O_5/ha) (kg P/ha)	Comments
Wheat	11,58	120-160	Atom (70%)and Spring (30%)	11,58	70-120 30,5-52,3	Typical NPK use fertilizers for star is 15:15:15 or 10:30:20 or 7:14:21, and for topdressing use is nitrogen fertilizers as is 27% KAN, or 46% UREE-a. Sometimes for topdressing farmers use also NPK formulation 15: 15:15 to.
Ray	0,66	100-120	Atom (70%) and Spring (30%)	0,66	90-100 39,3-43,6	Same like wheat
Barley	5,38	80-120	Spring (70%)and topdressing (30%)	5,38	90-110 39,3 – 48,0	Same like wheat

Crop	N FERTILISERS % Crop Receiving N Fertiliser	Typical Application Rate (kg N/ha)	Typical Timing of Application	P FERTILISERS % Crop Receiving P Fertiliser	Typical Application Rate (kg P_2O_5/ha) (kg P/ha)	Comments
Oats	2,13	80-100	Spring (80%) & topdressing (20%)	2,13	80-100 34,9 – 43,6	Same like wheat
Maize	23,2	150-200	Spring (50%) & topdressing (25 + 25%)	23,2	100-130 43,6 – 56,7	Same like wheat
Soya bean	0,19	30-70	Spring	0,19	120-130 52,3-56,7	NPK formulation 5:20:30
Tobacco	0,68	20-50	Spring (80%), topdressing (20%)	0,68	80-150 34,9-65,5	Typical 7:14:21
Potatoes	11,62	100-140	Spring (60 %) & top dressing (40 %)	11,62	90-120 339,3-52,3	NPK formulation 7:14:21 or 10:20:30 An topdressing 2 times with 27 KAN and 46% URRE-a
Field vegetables (except potatoes)	7,0	100-120	Spring (50%) & topdressing (20 +20+10%) Summer	7,0	100-120 43,6-52,3	Typical NPK formulation 7:14:21 or 15:15:15. The formulation 15:15:15 is often use for topdressing to
Glasshouse vegetables	0,83	150-180	Through the season (5 times)	0,83	110-130 48,0-56,7	NPK - 8:26:26, 7:14:21
Orchards	12,0	130-160	Spring (70 %), topdressing (30%)	12,0	90-120 39,3-52,3	Typical 7:14:21
Vineyards	2,0	110-140	Spring (70%), topdressing (30%)	2,0	80-110 34,9-48,0	Typical 7:14:21
Pasture and other grassland	22,39	80-120	Spring and summer (70 + 30 %)	22,39	70-90 30,5-39,3	Almost always 15:15:15

Known "Bad Practice" by Farmers Regarding Nutrient Management in the Federation of Bosnia & Herzegovina

Crops	Known Bad Practice by Farmers	Source of Information
Wheat, barley etc	Generally with cereals in BiH we have a very low yields in farmers plots. Reason for that is inadequate amount of fertilizers especially NPK and an proper NPK combination. Also in many cases physical condition of soil are very poor (heavy soils)	Personal experts experience and research work at the Agricultural Faculty of Sarajevo. There are no Government instructions for any agricultural practises, or government investigations of all this problems. This is for all crops mentioned in this table.
Maize	Poor soil fertility, inadequate hybrids, sowing on the slop, and bad equipped farmers.	
Tobacco	This production is almost abounded in Mediterranean region where was production of oriental tobacco. Nowadays production is mostly in northern part of the Country with tip of Virginia and Barley. Sometimes to high amount of nitrogen and as problem high amount of nicotine (bed qualities)	
Potatoes	Saving on the slop and erosion problem, seeds with no good quality, inadequate protection, and shortage of potassium in NPK formulation.	
Field vegetables (except potatoes)	The remarks from ordinary people is to high use of fertilizers especially nitrogen, but there is no official conformation about it. Also organic fertilizers is not use properly and close environmental problems to.	
Glasshouse vegetables	The remarks from ordinary people is to high use of fertilizers especially nitrogen, but there is no official conformation about it. Also organic fertilizers are not use properly and close environmental problems to. Artificial test and low quality by estimation ordinary people.	
Orchards	Bed agro technical practise (lack of cutting), bed protection practise, sidling material is low quality, growing on the to high slop, shortage of experience in intensive production and lack of research. No foliar application of fertilizers.	
Vineyards	The farmers have good experiences with this crop. On stony soils high loses of fertilizers by ground percolation.	
Pasture and other grassland	Still inadequate use of fertilizers, with problems and lack of other agro technical measures.	

Annex 3

Bulgaria

Annex 3: Bulgaria

Types of N and P Fertiliser Commonly Used by Farmers in Bulgaria

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
N FERTILISERS			
Straight N Fertilisers	Ammonium sulphate		
	Ammonium nitrate		Most commonly used N fertiliser
	Diamid of carbonic acid		Commonly used
	Sodium nitrate		
Compound Fertilisers	Mono-ammonium phosphate	N: 10-11%; P_2O_5: 46-50%	
	Di-ammonium phosphate	N: 20-21%; P_2O_5: 46-51%	
	Potassium nitrate	N: 13,5%; K_2O: 46%	
	N-K-Mg	N: 10%; K_2O: 15%; MgO: 7%	
	Nitrofoski	N: P_2O_5: K_2O –	
	Macro + Micro	N: 14%; P_2O_5: 4%; K_2O: 6% + micro-elements	They are produced with different nutrient ratios
	Deviferti-Betabor	N: 12%; P_2O_5: 2%; K_2O: 6% + micro-element B	
	Deviferti-Zeazinc	N: 14%; P_2O_5: 0%; K_2O: 6% + micro-element Zn	
	Deviferti- Feriazotan	N: 10%; P_2O_5: 0%; K_2O: 4% + micro-element Fe	
P FERTILISERS			
Straight P Fertilisers	Rock phosphate		
	Triple superphosphate		
	Superphosphate-fosphorite		
	Double superphosphate		
	Phosphorite flour		
	Bone flour		
Compound Fertilisers	Mono-ammonium phosphate	N: 10-11%; P_2O_5: 46-50%	
	Di-ammonium phosphate	N: 20-21%; P_2O_5: 46-51%	
	Nitrofoski	N: P_2O_5: K_2O –	They are produced with different nutrient ratios
	Macro + Micro	N: 14%; P_2O_5: 4%; K_2O: 6% + micro-elements	
	Deviferti-Betabor	N: 12%; P_2O_5: 2%; K_2O: 6% + micro-element B	

Total Consumption of N and P Fertiliser by Farmers in Bulgaria

		Year						
		1997	1998	1999	2000	2001	2002	Source of data
N FERTILISERS	Total N consumption (tonnes)	145773	97497	140269	144928	167962	155411	National Service for Plant Protection
	Total agricultural area treated with N fertilisers ('000s ha)			1417	1332	1468		National Service for Plant Protection
P FERTILISERS	Total N consumption (tonnes)	16275	8900	10367	16104	8474	21400	National Service for Plant Protection
	Total agricultural area treated with P fertilisers ('000s ha)			110,5	93,3	92,1		National Service for Plant Protection

Characteristics of N and P Fertiliser Use by Farmers in Bulgaria

	N FERTILISERS			P FERTILISERS	
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**
Wheat	77,7	86,0	Autumn (1/3 of the dose), spring (2/3 of the dose)	3,4	79,0
Barley	65,5	76,0	Automn (1/3 of the dose), spring (2/3 of the dose)	3,0	61,0
Maize	27,2	83,0	Spring	1,4	79,0
Sunflower	27,9	69,0	Spring	4,1	108,0
Sugar beet	No data	No data	Spring	No data	No data
Tobacco	44,5	43,0	Spring	0,0	0,0
Potatoes	39,0	121,0	Spring	11,1	96,0
Field vegetables (except potatoes)	10,3	136,0	Spring	0,02	96,0
Glasshouse vegetables	No data	No data		No data	No data
Orchards, vineyards	5,6	85,0	Spring (twice: I-March, II - end of may – beginning of June)	2,6	70,0
Pasture and other grassland	No data	No data	Spring	No data	No data

Additional Data

In 1999 485000 t of mannure have been used. The manure was applied only on 14800 ha – mainly potatoes and vegetables.
In 2002 240000 t of manure have been used- 85% of the quantity used in 2001.
The manure was applied on approximately 11900 ha - 85% of the acreage in 2001. In 2002 manure was applied mainly potatoes- 4840 ha, vegetables- 3220 ha, orchards - 280 ha, maize - 350 ha, other crops -770 ha.

Comments

While the optimum proportion N:P:K is 1:0,8:0,4, in 2000, N:P:K recorded 1:0,11:0,02, indicating an average use of phosphates nearly 8 times and use of potassium fertilizers over 20 times lower than the recommended.

In 2001 the ration was 1:0,05:0,01, that is an imbalance of 16 times less phosphorous and 40 times less potassium. For the past few years, this is the worst nutrient balance observed

In the country it is very commonly used the unbalanced fertilization (mainly with N). In many regions (Shoumen, Gabrovo, Lovetch, Sofia-town and Kardjali) was not used even a single tonne of K and Pthis reflects in the yields of the different crops as well as on their quality. It also leads to physisological disturbances in the cultivated crops that are results of the insufficient nutrients

The reasons for the decline of the use of the mineral fertilisers are different, but the main one is the high preces of the fertilizers on one hand and the limited financial resources of the farmers on the other. Another reason is the low efficiency of the inputs because the technologies are not strictly followed.

This information about bad practice comes from experts of National Service for Plant Protection.

Annex 4

Croatia

Annex 4: Croatia

Types of N and P Fertiliser Commonly Used by Farmers in Croatia

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
N FERTILISERS			
Straight N Fertilisers	Ammonium nitrate	33,5 %	
	Calcium ammonium nitrate	27 %	Very important and widely used type of single fertilizer in Croatia
	Urea	46 %	Very important and widely used type of single fertilizer in Croatia
	Urea ammonim nitrate – liquid fertilizer	30%	Relatively small amounts are sold because of different mechanization for application and lack of habit between farmers
Compound Fertilisers	Mono-ammonium phosphate	12:52:0	
P FERTILISERS			
Straight P Fertilisers	None		Only small amounts of these fertilizers are in use in Croatia because there is currently no demand for such fertilizers in farmer's community – they will probably became more important because of problems of P deficiency in soil.
Compound Fertilisers	Mono-ammonium phosphate	12-52-0 MAP	
	NPK 5-20-30S		Good for tobacco
	NPK 7-20-30		One of the most important fertilizers for basic fertilization
	NPK 8-16-24		
	NPK 8-26-26		One of the most important fertilizers for basic fertilization
	NPK 10-20-30		One of the most important fertilizers for basic fertilization
	NPK 10-30-20		This formulation is very good for soils low on plant available phosphorus, but farmers do not have habit to buy them because of higher price
	NPK 13-10-12		Good formulation for pre-seeding fertilization
	NPK 15-15-15		Farmers use this formulation very often in basic fertilization. The problem is that they applied too low amounts of phosphorus and potassium.
	NPK 20-10-10		Usually used for topdressing or sidedressing
	Other – please specify		There are also some amounts of compound fertilizers imported in Croatia by individuals or by companies, but there is no adequate statistics on quantities distributed in different parts of country. At the same time, some of the fertilizers sold in Croatia are transported to neighbouring countries.

Total Consumption of N and P Fertiliser by Farmers in Croatia

		Year						
		1997	**1998**	**1999**	**2000**	**2001**	**2002(?)**	**Source of data**
N FERTILISERS	Total N consumption (tonnes)	**126.462**	**98.818**	**104.822**	**110.471**	**109.798**		Petrokemija fertilizer plant – data on sale of fertilizers, Statistical yearbook, Personal calculation
	Total agricultural area treated with N fertilisers ('000s ha)	2992	3151	3151	3156	3148		Agricultural area
		1858	2021	1998	1994	1975		Cultivated area
		1441	1587	1586	1582	1576		Probably fertilized area (assumption)
P FERTILISERS	Total P consumption (tonnes) -as P2O5	**46.904**	**48.176**	**37.645**	**39.932**	**44.926**		Petrokemija fertilizer plant – data on sale of fertilizers, Statistical yearbook, Personal calculation
	Total agricultural area treated with P fertilisers ('000s ha)	2992	3151	3151	3156	3148		Agricultural area
		1858	2021	1998	1994	1975		Cultivated area
		1441	1587	1586	1582	1576		Probably fertilized area (assumption)

Characteristics of N and P Fertiliser Use by Farmers in Croatia

	N FERTILISERS			P FERTILISERS		
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**	**Comments**
Wheat, barley etc	95-100	100-200	Autumn - small amounts, spring 2-3 topdresings	95-100	50-100	
Maize	95-100	100-200	Autumn, spring, 1 topdressing	95-100	60-120	
Sunflower	95-100	80-120	Autumn, spring, ev. 1 topdressing	95-100	100-140	
Sugar beet	95-100	120-160	Autumn, spring, 1 topdressing	95-100	120-200	
Tobacco	95-100	20-40	Autumn, spring	95-100	80-160	
Potatoes	95-100	80-140	Autumn, spring, 1 topdressing	95-100	80-120	
Field vegetables (except potatoes)	95-100	100-400		95-100	80-160	
Glasshouse vegetables	100	100-400		100	80-160	
Orchards	40			40		
Vineyards	60			60		
Pasture and other grassland	0 (pastures) – 15 (grassland)			0 (pastures) – 15 (grassland)		

Known "Bad Practice" by Farmers Regarding Nutrient Management in Croatia

Crops	Known Bad Practice by Farmers	Source of Information
Wheat, barley etc	Fertilization is carried out without soil analyses and it is mainly based on farmer's experience and on general fertilization recommendations and habits in certain parts of Croatia	Well known fact
Maize	Farmers usually apply wrong formulation in autumn (15-15-15, Urea). That can cause imbalance in three major nutrients N, P and K later, and it can influence on nitrogen losses during winter	
Field vegetables (except potatoes)	Sometimes amounts of fertilizers are very high but it is production on relatively small area in Croatia, compared to the area under arable crops	
Orchards	From the agronomic point of view there is a lot of old orchards without any fertilization. Modern orchards are mainly fertilized according to the recommendations from the existing literature including modifications done by owners	
Vineyards	Same goes for the vineyards	
Pasture and other grassland	To low fertilization compared to the current state of domestic livestock production	

One of the most important indicators of intensity of agriculture is average mineral fertilizer consumption per unit of agricultural land. Problem is in a fact that in Croatia there is no one place or one institution responsible for evidence of consumption on territorial base. The farmers are not educated to take care about nutrient balance on their farms and there is no such program that will introduce some kind of "green accounting" at the farm level. The advantages of such practice can be expressed through the savings of money and better efficiency of mineral fertilizers.

Annex 5

Czech Republic

Annex 5: Czech Republic

Types of N and P Fertiliser Commonly Used by Farmers in the Czech Republic

Farmers in CZ are obligated to record data on fertilising their fields. No authority has collected this primary information yet. Therefore the consumption of various types of fertilisers in CZ is calculated from production, import and export data in next table.

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
			data from FAO Annual Questionaire on Fertilizers
N FERTILISERS			N t/year 2001
Straight N Fertilisers	Ammonium sulphate		18776
	Calcium nitrate		402
	Urea		49374
	Aqueous ammonia		98189
	Calcium ammonium nitrate		94306
Compound Fertilisers	Mono-ammonium phosphate		8173
	Other	20-20-0	614
		15-15-15, 22-8-8, 17-13-13	11396
P FERTILISERS			P t/year 2001
Straight P Fertilisers	Rock phosphate		
	Triple superphosphate		
	Single superphosphate (below 25% P2O5)		1857
	Concentrated superphosphate (25% P2O5 and over)		120
	Other –Basic slag		4847
Compound Fertilisers	Mono-ammonium phosphate		38628
	Other –	20-20-0	714
		15-15-15, 17-13-13, 12-12-12	6340

Total Consumption of N and P Fertiliser by Farmers in the Czech Republic

		1997	1998	1999	2000	2001	2002	Source of data
		Year						
N FERTILISERS	Total N consumption (tonnes)	205757	202932	200247	212988	225763	286600	the years 1997-2001 - Statistical Yearbook of the Czech Republic
	Total agricultural area ('000s ha)						2985	the year 2002 -
P FERTILISERS	Total P consumption (tonnes)	50411	45838	40270	39834	44397	50900	**Research Institute of Crop Production**
	Total agricultural area ('000s ha)						1258	

Characteristics of N and P Fertiliser Use by Farmers in Czech Republic

Crop	N FERTILISERS: % Crop Receiving N Fertiliser	N FERTILISERS: Typical Application Rate (kg N/ha)	N FERTILISERS: Typical Timing of Application	P FERTILISERS: % Crop Receiving P Fertiliser	P FERTILISERS: Typical Application Rate (kg P/ha)	Comments
Wheat spring	98	90	spring	38,6	31	Source of Information:
Wheat winter	100	122	autumn, spring	50,5	40	"%Crop" and "Application rate" - from
Barley spring	100	60	spring	54,3	33	Research Institute of Crop Production
Barley winter	100	92	autumn, spring	42,5	38	(tables prepared for FAO)
Rye	96	90	spring	17,8	38	
Oat	96	70	-"-	23,0	32	"Typical timing" – information from
Maize (for corn)	100	105	spring	77,4	39	district agriculture cunsultant
Sunflower	100	75	-"-	15,4	32	
Rapeseed	100	155	-"-	39,6	47	In face of economical situation
Sugar beet	100	92	-"-	66,9	43	majority of farmers keep to recommendation
Potatoes (early)	100	90	-"-	86,7	76	to apply two rations of N, first before
Potatoes (for starch industry)	100	120	-"-	99,1	82	seed-time, second later in spring.
Potatoes (ware)	100	100	-"-	78,2	70	In autumn there are applied P, K.
Field vegetables (except potatoes)	100	128	-"-	84,6	92	N fertiliser for winter cereals only.
Orchards	40	25		57,1	35	Orchards and vineyards – high rate in time of
Vineyards	100	50		100,0	65	their foundation.
Pasture and other grassland	44	50	spring, summer	3,1	6	Grassland - in spring or after haymaking,
Maize (green, silage)	98	120		42,8	51	but mostly animal manure is applied.

Known "Bad Practice" by Farmers Regarding Nutrient Management in the Czech Republic

There are not any problems with using the application rates that are higher than recommended rates or with applying mineral fertilisers at an inappropriate time of year. It is expensive for farmers to buy mineral fertilisers, so they effort to make use of them as most as possible.

An agriculture consultant is available in every district. Large farms and co-operative farms apply fertilisers according to chemical analysis of soils. The second rate of N fertilisers should be calculated in accordance with an expected harvest. This practice should be introduced at all farms, including small ones.

More problems are associated the application of animal fertilisers. Though there are strong rules when and how to use them, sometimes it can happen that they are applied at an inappropriate time because of the lack of storage capacity. The Czech Environment Inspection yearly solves a few accidents on streams that are related to use of slurry; such accidents are usually not related to use of mineral fertilisers.

Manure is commonly stored on fields; sometimes the manure/dung heaps are not secure enough.

According to my opinion (and based on the professional knowledge) one of greatest problems is arable land spreading very close to streams and rivers. There are not any legal rules for creating the protective zones along streams. Restrictions for farmers are only in water protection zones (drinking water).

The farmers are permanently informed to practice contour ploughing (not down hill one) and do not grow hazard crops (such as maize) on slope fields. Strict keeping this rule can help to avoid many problems on soil erosion.

Most vineyards are laid out in rows down the slopes. Only some vineyards and orchards from 70s´ and 80s´ practised terracing.

It would be necessary to convert some arable land on slopes to grassland and thus reduce the risk of erosions and loss of nutrients.

Additional Data

There is no central register of animal manure application. All this animal fertilisers should be return to agricultural land.

Annex 6

Hungary

Annex 6: Hungary

Types of N and P Fertiliser Commonly Used by Farmers in Hungary

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	(Yearly sales in 2001, tonnes)	(Yearly sales in 2000, tonnes)
N FERTILISERS (total)			**552224 t**	**594000 t**
Straight N Fertilisers	Ammonium sulphate		151 t	799 t
	Ammonium nitrate		312612 t (gran.)	343167 t (gran)
	Calcium nitrate		Soil fert., foliar fert., and nutrient solution	
	Urea		92543 t	94639 t
	Anhydrous ammonia		8079 t	53912 t
	Calcium ammonium nitrate		49865 t	42978 t
	Other Nitrogen fertilisers		88974 t	58505 t
Compound Fertilisers	Compound N fertilizers, granulated	15-15-15 15-10-20 15-10-10	68914 t 229 t 112 t	46595 t 482 t 215 t
	Foliar fertilizers		1815 t (In solutions)	643 t
P FERTILISERS (total)			**18902 t**	**15573 t**
Straight P Fertilisers	Triple superphosphate		Granulated fertiliser, used in diff. mixtures	
	Superphosphate		16866 t	15191 t
	Other P fertilizers total		2036 t	382 t
Compound Fertilisers	Mono-ammonium phosphate	12:62:0	Granulated fertiliser	
	Di-ammonium phosphate	21:54:0	Mostly in suspension form	
	Other comp. fertilizers with fixed formulation, granulated	11-53-0 0-10-24,5 8-21-21 8-16-30 2-18-18 7-12-12	21301 t 8059 t 7379 t 2678 t 778 t 42 t	18162 t 7687 t 7379 t 6068 t 390 t 137 t
	Other compound fertilizers, different formulation		82963 t	68566 t

Total Consumption of N and P Fertiliser by Farmers in Hungary

		Year						
		1997	**1998**	**1999**	**2000**	**2001**	**2002(?)**	**Source of data**
"Agricultural area" treated with mineral fertilizers								
"Enterprises and co-operatives	**Total ('000s ha)**	1841.7	1766.4	1519.8	1578.7	1571.8	1511.3	Hungarian Central Statistical Office
	arable land ('000s ha)	1799.5	1716.2	1540.8	1484.8	1530	1474.3	Research and Information Institute for Agricultural Economics (RIIAE)
	orchard ('000s ha)	7.6	9.4	8	9.5	10.3	9.6	
	vineyards ('000s ha)	2.1	1.8	2	3	3	2.4	
From which:	meadow, pasture ('000s ha)	29	31.5	24.6	20.2	24.5	25	
Private holdings	('000 ha)	1010.8	1749.1	1962.5	2148.5	2302.7	2301.9	Expert estimation
Total	('000 ha)	2852	3516	3482	3727	3875	3813	Expert estimation
Total NPK nutrients supply (tonnes)		285400	328100	346600	354800	395300	423300	Research and Information Institute for Agricultural Economics (RIIAE)
Specific NPK use (kg/ha)		46.1	53	56	60.6	67.4	72.2	Experts appraisal using official statistical data
	NPK nutrients used by enterprises and co-operatives (tonnes)	238800	235400	236700	224600	240100	257100	Hungarian Central Statistical Office "experts appraisal
	Specific NPK use (enterprises and co-operatives, average) (kg/ha)	85.3	86	88	85.5	109.4	119.7	Experts appraisal using official statistical data
	NPK nutrients used by private holdings (tonnes)	46600	92700	109900	130200	155200	166200	Experts appraisal
N FERTILISERS								
Total N nutrient supply	**(tonnes)**	206100	247900	262400	257700	275500	293700	Research and Information Institute for Agricultural Economics/HCSI
	N nutrient used by enterprises and co-operatives (tonnes)	172414	177962	179182	163059	192023	178427	Experts appraisal using national average nutrient ratio from statistics
	Total agricultural area treated with N fertilisers (enterprises and co-operatives, '000s ha)	1841.7	1766.4	1519.8	1578.7	1571.8	1511.3	Experts appraisal: 100 % of the treated area received N nutrient
	Specific N use (enterprises and co-operatives, average) (kg/ha)	98.5	106.1	182	108.7	128.6	120	Experts appraisal
	N nutrient used by private holdings (tonnes)	33686	69938	83218	94641	83477	115273	Experts appraisal using official statistical data

		Year						
		1997	**1998**	**1999**	**2000**	**2001**	**2002(?)**	**Source of data**
P FERTILISERS								
Total P supply	(tonnes)	42000	39100	39400	45100	57600	59800	Research and Information Institute for Agricultural Economics/HCSI
Total agricultural area treated with P fertilisers	(‘000s ha)	2139	2637	2612	2795	2906	2860	Experts appraisal: 75 % of the total treated area received P nutrient
	P nutrient used by enterprises and co-operatives (tonnes)	35103	26600	26984	28524	35054	36251	Experts appraisal using national average P nutrient ratio from the statistics
	Total agricultural area treated with P fertilisers (enterprises and co-operatives, ‘000s ha)	1841.7	1766.4	1519.8	1578.7	1571.8	1511.3””	Experts appraisal: 100 % of the treated area received P nutrient
	Specific P use (enterprises and co-operatives, average) (kg/ha)	19	15	18	18	22	24	Experts appraisal
	P nutrient used by private holdings (tonnes)	6897	12500	12416	16576	22546	23549	Experts appraisal using official statistical data
ANIMAL MANURE APPLICATION								
	Data from the enterprises and co-operatives only!							
Total manure applied from which applicated:	(‘000 tonnes)	4908	3257	3915	3863	2869	---	Hungarian Central Statistical Office
	On arable land (‘000 tonnes)	4839	3172	3822	3737	2746	---	Hungarian Central Statistical Office
	In orchards (‘000 tonnes)	30	38	49	52	42	---	Hungarian Central Statistical Office
	In vineyards (‘000 tonnes)	5	9	15	40	15	---	Hungarian Central Statistical Office
Agricultural area with manure application from witch:	Total (ha)	118238	92065	107910	104339	95898	---	Hungarian Central Statistical Office
	arable land (ha)	110293	84527	99592	96924	84632	---	Hungarian Central Statistical Office
	orchard (ha)	892	1086	1203	1475	1340	---	Hungarian Central Statistical Office
	vineyard (ha)	239	392	454	996	666	---	Hungarian Central l Statistical Office

Characteristics of N and P Fertiliser Use by Farmers in Hungary

	N FERTILISERS			P FERTILISERS		
Sector/Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**	**Comments**
Data from the enterprises and co-operatives only for 2002						
Wheat, barley etc	95	100-110	base 40 top 60-70	95	30-35	
Maize	96	100-110	base 60 top 40-50	96	20-30	
Sunflower,	91	50-60	base 35 top 25	91	20	
Sugar beet	88	60-70	base 30-35 top 40	88	50-60	
Potatoes		130-140			80-90	
Orchards (apple only)		40-50	base 20-25 top 20-25		20-25	
Vineyards		30-6+0			30-80	
Rape		105-115			30-40	
Peas	---	60	base 35 top 25		30	

Known "Bad Practice" by Farmers Regarding Nutrient Management in Hungary

No crop-specific information available - only general statements as follows:

- poor application due to old or poorly maintained equipment. The agricultural machinery in general – and the mineral fertiliser spreaders also – are mostly old and unsuitable for precise and equal spreading. For 10 years 70% of the machinery was more than 10 years old.
- spreading too closely to surface waters e.g. on hilly regions
- applying mineral fertiliser at an inappropriate time of year e.g. spreding the mineral fertilizers on the top of the snow in winter
- using application rates that are locally higher than optimal rates on big fields, where the soil quality differences are high.
- A big part of the fertilisers is only milled, their spreading parameters becoming worsen during the storage.
- The knowledge of the farmers is poor concerning the right adjustment and operating the spreaders.

(Sources of information: Report of Hungarian Institute of Agricultural Engineering, Gödöllő; Dr I. Marton: PhD dissertation, Keszthely,2001; Agroforum/ Plant nutrition section, 2002; Res. & Inf. Inst. For Agr.Economics - Report on Agrochemical plants, Education and Extension Institute of the Ministry of Agriculture)

Comments

1. There are official statistical data from the yearly sales (supply) of the mineral fertilisers regarding the nutrients, but no general cadastre from the real use of fertiliser on the fields (plots).
2. The yearly N and P nutrient use was calculated on the ground of the average N:P:K ratio from the total NPK "use"
3. There are more official data from the plant nutrition activity of the agricultural enterprises and co-operatives so the nutrient use of private holdings was calculated as the difference of the enterprises/co-operatives and the total.
4. The ratio of the land area treated with mineral fertilisers is approximately 70% of the total at the enterp./co-ops in average, at the main crops is higher, appr. 90%.
5. The consumption of mineral fertiliser at the enterprise/co-ops is much higher as the total average – but at present is not enough high – comparing to the needs. It means that the use of mineral fertiliser of the private holdings is even lower in average. Many of the private farmers do not use any fertilisers because of the lack of capital. We can calculate approximately the fertilised area in this segment with the average consumption and the real fertiliser quantity.

There are results of the nutrient use of the main crops and cultures from a representative survey made by the Central Soil and Plant Protection Service measuring more than 500 000 ha in all over Hungary. The average application rate is shown in the Table above. From the results we can state that all the fertilised crops were treated N and nutrients too. That is why the areas treated was calculated equally by the N and P fertilisation.

Annex 7

Moldova

Annex 7: Moldova

Types of N and P Fertiliser Commonly Used by Farmers in Moldova

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
N FERTILISERS			
Straight N Fertilisers	Ammonium nitrate		This type of fertiliser constitutes about 99% of total straight N fertilisers applied in Moldova
Compound Fertilisers	Mono-ammonium phosphate	11 : 44 : 0	This type of fertiliser constitutes about 40% of total compound fertilisers applied in Moldova
	Compound fertiliser "Nitroamofosca"	17 : 17 : 17	This type of fertiliser constitutes about 60% of total compound fertilisers applied in Moldova
P FERTILISERS			
Straight P Fertilisers			Not used
Compound Fertilisers	Mono-ammonium phosphate	11 : 44 : 0	This type of fertiliser constitutes about 40% of total compound fertilisers applied in Moldova
	Compound fertiliser "Nitroamofosca"	17 : 17 : 17	This type of fertiliser constitutes about 60% of total compound fertilisers applied in Moldova

Total Consumption of N and P Fertiliser by Farmers in Moldova

		Year						
		1997	**1998**	**1999**	**2000**	**2001**	**2002**	**Source of data**
N FERTILISERS	Total N consumption (tonnes)	11,70	19,90	6,70	8,10	13,45	20,58	Department for Soil Fertilization,State Inspectorate of the Ministry of Agriculture and Food Industry
	Total agricultural area treated ('000s ha)	377,4	568,6	197,0	270,0	395,6	588,0	As above
P FERTILISERS	Total P consumption (tonnes)	0,50	0,10	0,10	0,10	0,28	1,83	As above
	Total agricultural area treated ('000s ha)	26,3	4,5	5,0	5,9	12,2	83,2	As above

Characteristics of N and P Fertiliser Use by Farmers in Moldova

	N FERTILISERS			P FERTILISERS		
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**	**Comments**
Wheat, barley etc	60 - 75	35 - 55	In spring and summer	5 – 10	15 – 25	
Maize	10 - 15	25 - 35	In spring	0	0	The P fertilisers are not applied to maize because of the current economic situation
Sunflower	5 - 10	25 - 30	In spring	0	0	The P fertilisers are not applied to sunflower because of current economic situation
Sugar beet	35 - 45	35 - 55	In spring	30 - 40	15 – 30	
Tobacco	10 - 15	25 - 35	In spring	5 - 10	15 – 25	
Potatoes	30 - 40	25 – 35	In spring	30 – 40	20 – 25	
Field vegetables (except potatoes)	20 - 25	25 – 35	In spring and summer	20 – 25	15 – 25	
Glasshouse vegetables	60 - 80	25 – 30	In autumn and spring	60 – 80	15 - 25	
Orchards	0	0		0	0	The fertilisers are not applied to orchards because of current economic situation
Vineyards	0	0		0	0	The fertilisers are not applied to vineyards because of current economic situation
Pasture and other grassland	0	0		0	0	The fertilisers are not applied to pasture because of current economic situation

Known "Bad Practice" by Farmers Regarding Nutrient Management in Moldova

Crops	**Known Bad Practice by Farmers**	**Source of Information**
Wheat, barley, maize, sunflower	Unilateral application of straight N fertilisers (increase the risk of water pollution with nitrogen) Frequent fertilisers storage in unauthorized places	Mr Valentin Gurau, senior specialist of the Department for Soil Fertilization, Plant Protection with the State Inspectorate of the Ministry of Agriculture and Food Industry
Maize, sunflower, sugar beet, tobacco	Irregular application due to old equipment Frequent fertilisers storage in unauthorized places	As above
Potatoes, field vegetables	Spreading too closely to water sources (ponds and rivers)	As above
Glasshouse vegetables	Applying mineral fertilisers without estimate the nutrient needs of vegetables and soil test	As above

Additional Data

According to the data of the Department for Soil Fertilization, Plant Protection with the State Inspectorate in Moldova were applied for soil fertilization 157,837 tonnes of manure in 2001 and 199,245 tonnes – in 2002.

Currently the use of mineral fertilisers in agriculture of Moldova was reduced by 10 – 15 times comparative to the 1990s. At the moment in Moldova does not exist the special report on the environmental impact of mineral fertilisers use in the last years. The latest report on this issue is: "Nutrient Balances for Danube Countries. Country Report Moldova. Volume 1. 1996", which was prepared of the National Institute of Ecology. Some of these data's report were included in the "UNDP / GEF Danube Pollution Reduction Programme, National Review, 1998. Moldova. Executive Summary".

Annex 8

Romania

Annex 8: Romania

Types of N and P Fertiliser Commonly Used by Farmers in Romania

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
N FERTILISERS			
Straight N Fertilisers	Ammonium sulphate		21% N+24 S
	Ammonium nitrate		33-34.5% N
	Urea		46% N
	Aqueous ammonia		250 (2.9:0:0)
Compound Fertilisers	Mono-ammonium phosphate		61% P_2O_5 ; 12% N
	Di-ammonium phosphate		10% P_2O_5: 20%N
P FERTILISERS			
Straight P Fertilisers	Triple superphosphate		55-66 P_2O_5: 13-18 N
Compound Fertilisers	Mono-ammonium phosphate		48 P_2O_5: 11 N : 0 K
	Di-ammonium phosphate		10:20:0
	Poliphosphats		56-60 13-18 0

Total Consumption of N and P Fertiliser by Farmers in Romania

		Year						
		1991	**1998**	**1999**	**2000**	**2001**	**2002**	**Source of data**
N FERTILISERS	Total N consumption (tonnes)	651	505	495	460	390	340	Agriculture Ministry
	Total agricultural area treated ('000s ha)	5400000	4200000	3100000	2900000	2700000	2500000	
P FERTILISERS	Total N consumption (tonnes)	313	225	218	205	183	165	As above
	Total agricultural area treated ('000s ha)	2900000	2050000	1950000	1800000	1750000	1700000	

Characteristics of N and P Fertiliser Use by Farmers in Romania

	N FERTILISERS			P FERTILISERS		
Crop	% Crop Receiving N Fertiliser	Typical Application Rate (kg N/ha)	Typical Timing of Application	% Crop Receiving P Fertiliser	Typical Application Rate (kg P/ha)	Comments
Wheat, barley etc	45	30-66	autumn	48	30-60	N 45: P 23: K 0.5: trends in fertiliser use
Maize	35	48-60	spring	20	48-60	-//- -//- -//-
Sunflower	40	48-60	spring	20	48	
Sugar beet	40	60-80	spring	48	48-60	
Tobacco	20	20-45	spring	20	40-60	
Potatoes	60	60-120	spring	40	60-80	
Field vegetables (except potatoes)	65	60-80	spring	45	30-60	
Glasshouse vegetables	85	60-80	vegetation	35	30-70	
Orchards	20	40-60	vegetation	20	30-40	
Vineyards	45	30-60	spring	25	30-40	
Pasture and other grassland	15	30	spring	-	-	

Annex 9

Serbia & Montenegro

Annex 9: Serbia & Montenegro

Types of N and P Fertiliser Commonly Used by Farmers in Serbia & Montenegro

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments (Trade names of Fertilizer and Labelling)
N FERTILISERS			
Straight N Fertilisers	Ammonium nitrate		AN 30-35%
	Calcium nitrate		CALCIJUM NITRAT 15,5+25,5%
	Urea (Carbamid)		UREA 44-46 %; Terafert 36%
Compound Fertilisers	Mono-ammonium phosphate	N-11,1 % +P_2O_5-51,8 %	
	Chilean Nitrate (KNO3)	N-13%+K-46%	
	NPK in Different %	15:15:15; 13:13:13; 14:14:14; 10:30:10; 8:16:24; 7:14:24; 12:24:12; 17:13:10	No specific Names
	Compound Hard Fertilisers with Microelements		NPK + Microelements (B, Cu, Fe, Mn, Mo, Zn, Mg etc.)
	Compound Liquid Fertilisers with Microelements		NPK + Microelements (B, Cu, Fe, Mn, Mo, Zn, Mg etc.)
P FERTILISERS			
Straight P Fertilisers	Rock phosphate (SP)		SP – Powder 16-18%, SP – Granulate 17,5 – 19%
	Triple superphosphate (TSP)		TSP- Powder 43-43,5 %, Granulate 45,1 %
Compound Fertilisers	Duo – Calcium	40% P2O5	-
	Calcium – P	60-65%	-
	Other,	20-30%	-
	Other, 5-8%	P2O5	Other, 5,5-7% P

Total Consumption of N and P Fertiliser by Farmers in Serbia & Montenegro

		Year						
		1997	**1998**	**1999**	**2000**	**2001**	**2002(?)**	**Source of data**
N FERTILISERS	Total N consumption (tonnes)	89.000	89.000	70.000	74.000	92.000	66.000	Statistical Yearbook of the FRY, 2002
	Total agricultural area treated with N fertilisers (‘000s ha)	2.382	2.360	2.128	2.750	2.630	2.300	Statistical Yearbook of the FRY, 2002
P FERTILISERS	Total N consumption (tonnes)	26.000	20.000	14.000	16.000	19.000	18.600	Statistical Yearbook of the FRY, 2002
	Total agricultural area treated with P fertilisers (‘000s ha)	2.380	2.410	2.350	2.340	2.730	2.347	Statistical Yearbook of the FRY, 2002

N – Consumption (Wheat, Maize, Sugar beet, Sunflower)
P – Consumption (Maize, Sugar beat, Sunflower, Soya been, Vegetable, Fodder Crops)

Characteristics of N and P Fertiliser Use by Farmers in Serbia & Montenegro

	N FERTILISERS			P FERTILISERS			
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Application Rate (kg P/ha)**	**Comments**
Wheat, barley etc	95	250	Top Dressing	5	30	Basic Fertilising	
Maize	50	100	Top Dressing	100	200	Basic Fertilising	
Sunflower	50	95-127	Top Dressing	100	100-120	Basic Fertilising	
Sugar beet	80	116-159	Top Dressing	100	110-150	Basic Fertilising	
Tobacco	50	46-83	Top Dressing	90	88-112	Basic Fertilising	
Potatoes	20	140	Top Dressing	90	105-114	Basic Fertilising	Manure
Field vegetables (except potatoes)	50	100	Top Dressing	80	150	Basic Fertilising	Manure
Glasshouse vegetables	70	150	Top Dressing	90	200	Basic Fertilising	Manure
Orchards	70	100	Top Dressing	20	200	Basic Fertilising	Manure
Vineyards	80	100	Top Dressing	40	200	Basic Fertilising	Manure
Pasture and other grassland	No	No	Top Dressing	10	200	Basic Fertilising	Liquid Manure

Known “Bad Practice” by Farmers Regarding Nutrient Management in Serbia & Montenegro

Crops	Known Bad Practice by Farmers	Source of Information
Wheat, barley etc	No application of Basic Fertilizer	Common practice by farmers caused by inadequate education and awareness absence of the negative environment impacts. Own experience and experts knowledge from Faculty of Agriculture, Information from Farmers and Local Communities.
Maize	Application of basic fertilizer in inappropriate time, that is before sowing and not in autumn by tilling.	
Sunflower		
Sugar beet		
Tobacco		
Potatoes		
Orchards	Small quantity applied without analysis of soil chemical contents and quality.	
Pasture and other grassland	No control of using liquid manure.	
Others	Using of all kind of fertilizer close to the water (rivers, springs, etc.)	

Annex 10

Slovakia

Annex 10: Slovakia

Types of N and P Fertiliser Commonly Used by Farmers in Slovakia

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
N FERTILISERS			
Straight N Fertilisers	Ammonium sulphate		7% share on total within N fertilisers in 2002
	Ammonium nitrate		7.1% share on total within N fertilisers in 2002
	Ammonium-calcium nitrate		45.4% share on total within N fertilisers in 2002
	Urea		15.2% share on total within N fertilisers in 2002
	Ammonium nitrate with urea (liquid fertiliser)		14.2% share on total within N fertilisers in 2002
	Ammonium nitrate with ammonium sulphate		9.6% share on total within N fertilisers in 2002
P FERTILISERS			
Straight P Fertilisers	Triple superphosphate		25.8% share on total within P fertilisers in 2002
	Single superphosphate		60% share on total within P fertilisers in 2002
	Hyperphosphate (12.3% P)		14.2% share on total within P fertilisers in 2002
Compound Fertilisers	Mono-ammonium phosphate		(8534 t in 2002)
	Compound NPK fertilisers (in different N-P-K ratios)	NPK 15-15-15 dominates within NPK fertilisers – 42.3 t	Dominate in the structure of compound fertilisers (93174 t in 2002).

Total Consumption of N and P Fertiliser by Farmers in Slovakia

		Year						
		1997	**1998**	**1999**	**2000**	**2001**	**2002(?)**	**Source of data**
N FERTILISERS	Total N consumption (tonnes)	88017	81842	65393	72653	76032	81792	Slovak Statistical Office data
	Total agricultural area treated (‘000s ha)							
P FERTILISERS	Total P consumption (tonnes) – as P_2O_5	24494	20475	13115	15731	17559	18493	Slovak Statistical Office data
	Total agricultural area treated (‘000s ha)							

Characteristics of N and P Fertiliser Use by Farmers in Slovakia

	N FERTILISERS			P FERTILISERS		
Crop	**% Crop Receiving N Fertiliser**	**Typical (average) Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical (average) Application Rate (kg P/ha)**	**Comments**
Wheat, barley etc	90-100%	40 – 90	mostly in spring		4 – 9	
Grain maize	90-100%	100	In spring		9	
Sunflower	90-100%	75	In spring		7	
Sugar beet	90-100 %	70	In spring		15	
Tobacco	90-100 %	25	Before seeding		17	
Potatoes	90-100 %	95	In spring		19	
Field vegetables (except potatoes)	90-100 %	80 – 120	In spring		9 – 18	
Glasshouse vegetables	(100%)		before/after planting			
Orchards	40-50 %	50	In spring		11	
Vineyards	50-60 %	60	In spring		15	
Pasture and other grassland	30-40 %	20	after cuts✶		1	✶Not after the last
Rape (seeds)	90-100 %	130	Mostly in spring		10	
Silage maize	60-70 %	83	Before seeding		5	

The rate of phosphorus is often a result of compound fertilisers use

Known "Bad Practice" by Farmers Regarding Nutrient Management in Slovakia

There are rather general opinions of inappropriate fertiliser and animal manure utilisation as follows:

- often neglecting of nutrients applied especially from liquid manures
- use NPK fertilisers is not always appropriate to meet the crop demands with regard to actual inorganic N, available P and K supply within concrete field (Compound NPK fertiliser can not be applied in autumn when in the soil is sufficient N_{in} supply – often after legumes or liquid animal manure application or as consequence of residual N in the soil; by compound NPK fertiliser can not cover different crop needs on nutrients such as P and K when their available soil supply is different – occurrence of under/over -fertilisation).
- use of soil analysis for precision the splitted N-rates is not systematic and rather oriented on market crops (winter wheat, spring barley, sugar beet)
- good agriculture practice (environmentally oriented) is in the stage of introducing into farm management - so inconsistency occurs.

Additional Data

Precise information on area treated with N and P fertilisers is not available; use of fertilisers is monitored on around 70 % of agricultural soil – involved set of farms depends on return of completed questionnaires sent to the farmers. Official statistical data are assuming the total agricultural area. Of course, mineral fertilisers are primarily concerned on arable land.

Annex 11

Slovenia

Annex 11: Slovenia

Types of N and P Fertiliser Commonly Used by Farmers in Slovenia

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments
N FERTILISERS			
Straight N Fertilisers	Ammonium nitrate		Not widely used
	Calcium nitrate		Not widely used
	Urea		Not widely used
	Calcium ammonium nitrate/ Urea ammonium nitrate		Mostly used
Compound Fertilisers	Mono-ammonium phosphate	12 %	
	NPK with emphasis on P and K	15:15:15, 7:20:30, 8:26:26	Mostly used
	NPK with Mg and B		For sugar beet, orchards, vineyards
	NK 16:00:44	16 %	
P FERTILISERS			
Straight P Fertilisers	Rock phosphate		Available but too expensive for the farmers to use
Compound Fertilisers	Mono-ammonium phosphate	12 – 52 – 0	Not widely used
	Other – PK	0 – 15 – 30	Not widely used

Total Consumption of N and P Fertiliser by Farmers in Slovenia

		Year					
		1997	**1998**	**1999**	**2000**	**2001**	**Source of data**
N FERTILISERS	Total N consumption (tonnes)	34102	34813	34392	34847	34771	Statistical office of RS
	Total agricultural area treated (‘000s ha)	411	410	439	431	434	arable land, permanent crops and cut grassland (2 or more cuts)
P FERTILISERS	Total P consumption (tonnes)	17534	18785	19751	18375	16685	
	Total agricultural area treated (‘000s ha)	411	410	439	431	434	arable land, permanent crops and cut grassland (2 or more cuts)

Characteristics of N and P Fertiliser Use by Farmers in Slovenia

	N FERTILISERS			P FERTILISERS		
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**	**Comments**
Wheat, barley etc	90	40 – 60	March, April, May, September*	80	60 – 80	* winter wheat
Maize	90	50 – 100	April, May, beginning of June	80	60 – 100	
Sugar beet	100	40 – 80	½ at sowing time, ½ side dressing	100	100	
Potatoes	80	80 – 140		80	60 – 100	
Field vegetables (except potatoes)	100	With fertigation: 10 – 20 Without fertigation: 50 – 100	*	With fertigation: 100	5 – 10 50 – 100	* depends on the type of vegetable mostly March - September
Glasshouse vegetables	100	20 50 – 100	Whole year	100	10 100	
Orchards	75*	50 – 70	Budbreak	75*	20	* intensive orchards
Vineyards	60	50	15.4. – 15.6.	30 – 40	50	
Pasture and other grassland	25	50	March – May	25	20	

IMPORTANT: There is no statistical data available, therefore these raw estimations are based on an expert knowledge.

Known "Bad Practice" by Farmers Regarding Nutrient Management in Slovenia

Crops	Known Bad Practice by Farmers	Source of Information
Wheat, barley etc	Over dosage of N at sowing (>40 kg N/ha)	Chair for Crop Science and Sustainable Farming, Agricultural Institute of Slovenia
Maize	On large livestock farms soils are rich with organic N an therefore any N addition is superfluous	
Sugar beet	On large livestock farms soils are rich with organic N an therefore any N addition is superfluous	
Potatoes	Over dosage of N and P	Agricultural Institute of Slovenia
Field vegetables (except potatoes)	Over dosage of N and P	
Glasshouse vegetables	Over dosage of N and P	
Orchards	Where the Integrated fruit production rules are not practised, which is 15% of the whole Slovenian fruit production	Chair for Fruit Production, Biotechnical Faculty, Agricultural Institute of Slovenia
Pasture and other grassland	Low values of P and K due to the unsuitable use mineral fertilisers	Agricultural Institute of Slovenia
Others	Spreading too closely to water sources is (or it use to be) a common practice. "Water act" which has been accepted in 2002 interdicts spreading fertilisers or pesticides in the 5 m strip near smaller creaks and in 15 m strip near main water courses.	

Annex 12

Ukraine

Annex 12: Ukraine

Types of N and P Fertiliser Commonly Used by Farmers in Ukraine

Type of Fertiliser	Typical Nutrient-containing Chemicals	Typical Formulation (N:P:K)	Comments (product names)
N FERTILISERS			
Straight N Fertilisers	Ammonium sulphate		
	Ammonium nitrate		
	Urea		
	Ammonium sulphate		
Compound Fertilisers	Mono-ammonium Phosphate	N -11%; P_2O_5 - 49%; N - 3%; P_2O_5 - 5%; N -2%; P_2O_5 - 16%; N -1-2%; P_2O_5 -18-29%; N - 3%; P_2O_5 -17-18%	Superagro NP, Ammonium Phosphate, 2-16-0; Granphose
	Diammonium Phosphate	N -16%; P_2O_5 -16%	Ammophosphate NP
	Compound - NK	N -10%; K_2O -6%; S -5%; B -0,4%	Ecolist
	Compound – various NPK	N -3-20%; P_2O_5 -5-41%; K_2O -8-38%; N -2,1-6%; P_2O_5 - 0,8-17%; K_2O -0,8-14,0%; N -6-18%; P_2O_5 -7-24%; K_2O -8-24%; N -10-17%; P_2O_5 -9-19%; K_2O -9-17%; N -8-18%; P_2O_5 -5-17%; K_2O -16-28%; N -4,3%; P_2O_5 - 1,9%; K_2O -1,9%; N -3%; P_2O_5 -5%; K_2O -5%;	Aquarine; Tekos; Kemira NPK; Nitrogranphoska; Rastvorin; Riverm; Superagro NPK
P FERTILISERS			
Straight P Fertilisers	Super Phospfate (GR)	P_2O_5 - 17%-20%	
Compound Fertilisers	Mono-ammonium Phosphate	N -11%; P_2O_5 - 49%; N - 3%; P_2O_5 - 5%; N -2%; P_2O_5 - 16%; N -1-2%; P_2O_5 -18-29%; N - 3%; P_2O_5 -17-18%	Superagro NP, Ammonium Phosphate, 2-16-0; Granphose
	Di-ammonium Phosphate	N -16%; P_2O_5 -16%	Ammophosphate NP
	Compound - PK	P_2O_5 -14,4%; K_2O -14,5%	Granphoska
	Compound – various NPK	N -3-20%; P_2O_5 -5-41%; K_2O -8-38%; N -2,1-6%; P_2O_5 - 0,8-17%; K_2O -0,8-14,0%; N -6-18%; P_2O_5 -7-24%; K_2O -8-24%; N -10-17%; P_2O_5 -9-19%; K_2O -9-17%; N -8-18%; P_2O_5 -5-17%; K_2O -16-28%; N -4,3%; P_2O_5 - 1,9%; K_2O -1,9%; N -3%; P_2O_5 -5%; K_2O -5%;	Aquarine; Tekos; Kemira NPK; Nitrogranphoska; Rastvorin; Riverm; Superagro NPK

Total Consumption of N and P Fertiliser by Farmers in Ukraine

		Year						
		1997	1998	1999	2000	2001	2002	Comments
N FERTILISERS	Total N consumption (tonnes)	410,3	406,5	327,2	223,3	318,2	311,1	
	Total agricultural area treated with N fertilisers (‘000s ha)	9317	8204	7196	4632	6388	6226	
P FERTILISERS	Total N consumption (tonnes)	103,7	76,1	62,0	37,6	52,0	55,0	
	Total agricultural area treated with P fertilisers (‘000s ha)	9317	8204	7196	4632	6388	6226	

Characteristics of N and P Fertiliser Use by Farmers in Ukraine

	N FERTILISERS			P FERTILISERS		
Crop	**% Crop Receiving N Fertiliser**	**Typical Application Rate (kg N/ha)**	**Typical Timing of Application**	**% Crop Receiving P Fertiliser**	**Typical Application Rate (kg P/ha)**	**Comments**
Wheat, barley etc	60	33	spring	60	31	
Maize	42	27	spring		7,2	
Sunflower	12	2,5	spring		2,1	
Sugar beet	68	59	spring		20	
Tobacco	-	-	-	-	-	
Potatoes	52	39	spring		26	
Field vegetables (except potatoes)	31	27	spring		12	
Pasture and other grassland	13	5,8	spring		0,6	

Known "Bad Practice" by Farmers Regarding Nutrient Management in Ukraine

Agricultural policy of Ukraine in part of agrochemical protection of plants and certain out of control activities of farmers make the agri-industrial sector un efficient. It causes overuse of fertilisers and pesticides and does facilitate pollution of the environment - particularly water, air and soil. It also induces soil erosion and sedimentation of water reservoirs.

There are the following bad agricultural practices that are common in Ukraine:

- Farmers use out of date, illegal and non-certified pesticides and fertilisers that cost much less than normal. The practice causes soil oxidisation and has unpredictable effects on the environment and crops.
- Farmers apply machines with non-point sprayers. It makes fertilisers spread too largely and thus contaminate soils and water. It also causes over-enrichment of fertilisers to crops.
- There are no unique or complex fertilisers. Farmers use several kinds of fertilisers for every certain kind of weeds and pests. It results in mixing of fertilisers and thus unpredictable influence on the environment and crops.
- Farmers do not apply the practice of vegetative cover. It makes pollutants come easily to air and finally drop down into water and soils.
- No practice of covered storage of animal wastes. It causes air pollution and water eutrophication (nitrogen and phosphorous load).
- Farmers do not apply the practice of crop rotation following short-term economic purposes. Steadily it causes more and more poor yields and thus farmers apply more and more fertilisers.
- Local agriculture and forest bodies do not provide planting of forest and grass buffers around agricultural fields in order to protect water basins from sedimentation.
- Local agriculture, forest and water industry bodies do not provide engineering protection of water streams and water reservoirs from sedimentation due to agricultural activity.
- In Ukraine around 19 thousand tones of pesticides prohibited for use are stored. The Cabinet of Ministers of Ukraine issued the Decree that prohibited some chemical weeds- and plants-killers. Hence agricultural enterprises came Negative list fertilisers to specials storage places. For the time being the chemicals started dropping down to soils and contaminating water and air.