Confidential report
CEFIC / IFP

The contribution of Inorganic Feed Phosphates to the European P-soil status.

Preface:

Phosphorus is essential to all living organisms and, together with nitrogen, it is one of the main nutrients for animals and plants. However, an oversupply of nitrogen and phosphorus can modify the natural environmental balance of ecosystems. This is often the result of increased livestock production and increasing animal density. In case of phosphorus, the contribution made by inorganic feed phosphates are quite often being identified as the main cause of phosphorus inputs exceeding take-up and thus causing eutrophication of natural water sources and other problems like excessive algal blooms.

The aim of this document is to put the contribution that inorganic feed phosphates (IFP) make to the phosphorus (P) content in livestock manure and ultimately the environment, into the right perspective. Attention will be given to the use of P in agriculture both via the use of manure and mineral fertilizers in relation with P-uptake by crops. Firstly, the use of feed materials will, therefore, be discussed being the origin of P in manure. Also individual countries in the EU will be discussed in view to phosphorus excretion, as calculated by different animal types. Because there are significant differences between the different types of feed phosphates in respect of environmental load these differences and possible solutions will also be discussed.

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IFP sector group
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Executive Summary:

The objective of this document is to put into perspective the contribution that inorganic feed phosphate (IFP) make to the phosphorus content in manure and to the total application of P to the soil by agriculture.

Introduction:

Increasing environmental pressure and tightening legislation to decrease phosphorus (P) load on the environment lead to re-think mineral nutrition of livestock. It's a general opinion that supplementary feed phosphates are the biggest contributors to the P load in manure. The seemingly logical move in an attempt to decrease the P load is therefore to decrease IFP levels in diets of high producing livestock.

Feed usage and composition:

Animal feeds are for the greater part composed of vegetal materials, including roughages, grain and oilseed products totalling approximately 450 million tonnes of feedstuffs each year. All (vegetal) feed materials contain intrinsic levels of phosphorus, but this is usually present at low and variable levels. Moreover, the digestibility of this phosphorus is often too low to satisfy the animal's need for phosphorus. In general, only 30% of the P in vegetal sources is available for monogastric animals.

Phosporus requirements:

Both crops and animals have a basic requirement for P. Together with livestock manure, a number of P-containing fertilisers are used to supply the soil and thereby the plant with sufficient levels of P. Like plants, animals also have a basic P-requirement. P-deficiency can impair animal health and welfare and also can have significant economic consequences to the livestock producer. Under most circumstances, in order to meet the P requirements for production, feeds for monogastric animals have to be supplemented with P-rich materials such as IFPs, which contain a high concentration of digestible P (dP).

IFP sources:

A wide choice of inorganic feed phosphates is available to livestock producers and feed manufacturers in Europe today. The most commonly used forms of feed phosphates are monocalcium (MCP), monodicalcium (MDCP), anhydrate and dihydrate dicalcium phosphates (DCP.0H2O/ DCP.2H2O), and to a lesser extent magnesium phosphate (MgP), monoammonium phosphate (MAP) and monosodium phosphate (MSP). Also available, although not produced in the EU, is defluorinated phosphate (DFP). IFP sources differ with respect to their mineral content and chemical composition and consequently with regard to their total P-content and P-digestibility. In vivo trials consistently show that with regard to the inorganic feed phosphates, the ranking in terms of bioavailability (expressed as dP[1]) for both pigs and poultry is as follows: MSP, MAP and MCP have the highest availability ranging between 75-92%, followed by DCP

[1] Digestible P = the difference between intake of P and excretion of P via the faeces, in case of poultry including excretion via the urine.

dihydrate (DCP.2H2O) and MDCP (75-85%). DCP anhydrate (DCP.0H2O) has a lower digestibility (55-73%) and DFP having by far the lowest dP value (55-60%).

P application to the soil
Phosphorus excretion is an inevitable consequence of livestock production. In total almost 1.6 million tonnes of P per year is excreted in the manure within EU 15 and this manure is mostly used as an agricultural fertiliser source. In order to fulfil the mineral requirements of plants, mineral fertilisers are used on arable land to balance livestock manure. The total P application of both manure and mineral fertilisers per hectare is 24 kg of P on average, totalling 3.2 million tonnes of P. The removal of P by crops at harvest, is on average 20 kg P per hectare.

P contribution of IFP to the soil in perspective
IFPs are used to balance animal feeds due to their P-content. The annual total use of IFP is estimated to reach 1.4 million tonnes for EU 25 (expressed in DCP 18 equivalence) or 0.25 million tonnes expressed as total P. This is almost 11% of the total P consumed by livestock via feed materials. Taking in account the IFP consumption per specie and the livestock numbers within the EU15, an estimation of the IFP contribution to the total P in the manure can be calculated. Due to the high digestibility of IFP sources the total contribution of P in the manure from IFP is calculated to be about 75.600 tonnes P per year, which is approximately 4.6% of the total P in the manure. The balance, 95.4%, is P originating from the other feed materials in the diets, including the use of phytase. In relation to the total average P-application per hectare from livestock manure and mineral fertilisers (26 kg), the contribution of IFP is only 2.3% of the total P-application. This equates to 0.6 kg/ha/year.

Possible scenarios to limit P-excretion in livestock manure
Although most European countries have already national programmes and projects aimed at reducing phosphorus losses from agricultural sources to the environment, some possibilities still do exist to limit P-excretion further. This includes 1) the lower use of IFP (by legislation) by fixing possible maximum levels; 2) lower the P norms to which feeds are formulated; or 3) to increase the dP level in the IFP used. With the exception of the latter, all these measurements have only a small or even counter-productive effect, certainly when IFP are replaced by other feed materials having a lower P-digestibility. The risk exists of feeding the animals below requirement and, at the same time, increase the P output into the manure.
There is however no common definition for highly digestible IFP sources in the EU and no standard evaluation method exist to assist in differentiating between the digestibility's of IFPs. The development of a standardised test for retrieving P-digestibility values for feed materials and IFP should be prioritised. It is therefore recommended to develop such a method within the framework of one of the projects of DG-research. The setting of benchmark values is essential to further optimise the use of IFP.

From a farmers view, it is more important to maximise the recycling and utilisation of the nutrients in manure, which have to be considered as valuable resource instead of problematic waste.

The contribution of Inorganic Feed Phosphates to the European P-soil status.

Introduction:

Feed usage and composition:
Animal production in the EU has increased significantly over the last 50 years, and today the EU has become the world's largest exporter and importer of agricultural produce (including animal products). In order to achieve performance objectives from animals, feeds (industrial) are composed from a mixture of feed materials. In total approximately 450 mln t of feedstuffs are used each year[2] (figure 1). Out of this quantity, 216 mln t are roughages grown and used on the farm of origin. The balance, i.e. 234 mln t. of feed, includes cereals grown and used on the farm of origin (51 mln t) and feed purchased by livestock producers to supplement their own feed resources (feed materials or industrial feed).

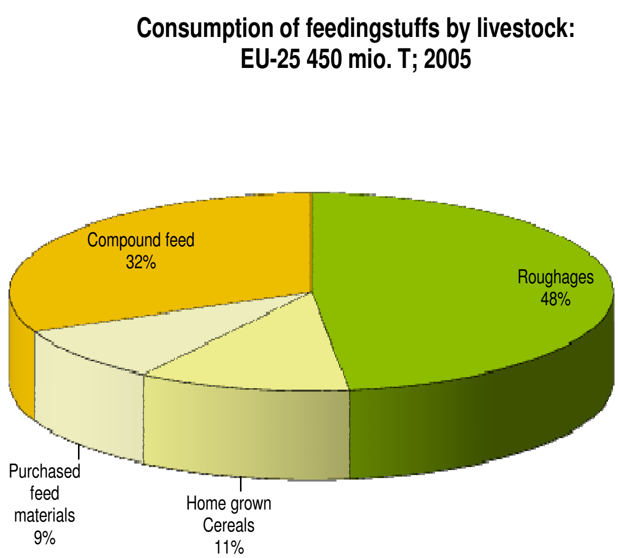

Figure 1.

In 2005, 141.9 mln t of industrial feeds were produced by EU feed compounders. Industrial feed is used either as a complete daily ration for the animals or as a tool to correct unbalances in the feed materials fed to livestock, in the form of compound feeds, feed concentrates or free access mineral mixtures (Figure 2).

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[2] EU-25, Fefac Feed&Food Statistical Yearbook 2006?

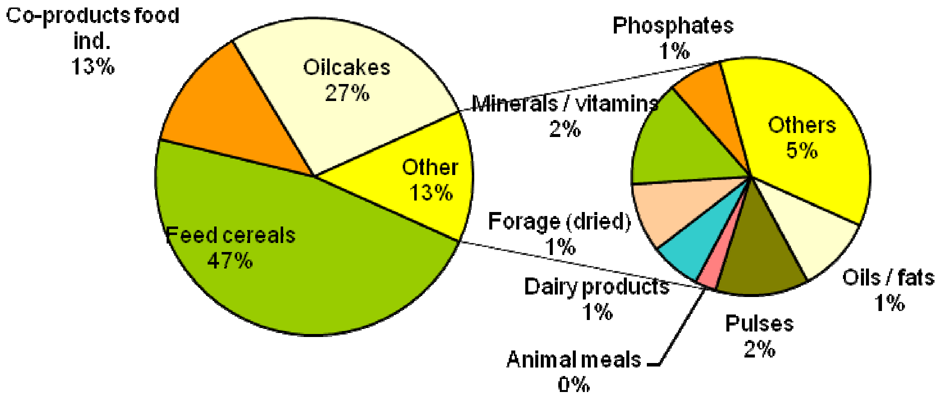

Figure 2: Feed material consumption for Industrial Feed; total use 141.9 mln T, EU 25, 2005.

Animal production is achieved by using feed (industrial or compound) which include minimum quantities of energy, protein but also phosphorus (table 1).

Table 1: Typical compound feed formulations for pig and poultry (Benelux)		
Feed composition (%)	Pigs	Broilers
Maize	19	20
Wheat	30	39
Wheat middlings	20	
Soya	17	29
Fish meal		2
Tapioca	6	
Molasses	4	
Fat	2.2	7.6
Other	1.4	1.1
Feed Phosphate	0.4 (MCP)	1.3 (DCP)
Phosphorus content (%)		
Total phosphorus	0.55	0.67
Digestible / available phosphorus	0.24	0.40
Requirement digestible / available P met by (%)		
Vegetable phosphorus	83	52
Animal origin phosphorus		13
Inorganic phosphorus	17	35

Source: A guide to feed phosphates, CEFIC/IFP, 1999

Phosphorus sources and phosphorus digestibility:

An adequate supply of phosphorus in animal feeds is vital for optimal performance of livestock. Phosphorus supply in animal feeds has different origins : 1. plant origin 2. animal origin (mainly fish meal) and 3. inorganic feed phosphates (IFP). (Bio)-Availability or digestibility is used to describe to what extent an animal can utilise a given nutrient. Knowing the digestibility of a nutrient e.g. phosphorus makes it possible to optimise feed according to the animal's requirement for digestible P and not for total P. In this way not only the excretion of unutilised P is reduced, but formulation cost and diet space is optimised. Several methods are used to test the utilisation of inorganic phosphorus sources and care should be taken in the interpretation of digestibility coefficients. Digestible P in this document refers to the difference between intake of P and excretion of P via the faeces, in case of poultry including excretion via the urine[3].

Phosphorus from plant origin

The most common form of organic phosphorus in plants is in the form of phytate phosphorus, phytin. Phytin represents the main storage of phosphorus in plants and occurs as an insoluble complex at a physiological pH of 6.8 – 7.4. This means that the phosphorus is not available for monogastric animals (poultry, pigs) and explains the low intrinsic availability of phosphorus in animal feeds. In order for animals to make use of the phosphorus it has to be in the inorganic form, i.e. the phytate phosphorus must go through a conversion to inorganic phosphorus – this is made possible by enzymes such as phosphatase and phytase. The value of phytate as a source of phosphorus is depended on many factors particularly the phytase enzyme activity in the feed, the levels of added Ca and P in the feed and the physiological status of the animal. About two thirds of the total phosphorus in feed ingredients of plant origin is phytate. Within different feed ingredients the availability differs considerably. This is due to varying total P concentration as well as endogenous phytase activity which varies considerably. The varying levels of total phosphorus and differences in digestibility make it difficult to accurately estimate the actual amount of digestible phosphorus supplied to the animal, with the risk of both over and under estimation. Accurate information regarding digestible phosphorus is essential for precise feed formulation. Today, there is no rapid method to routinely determine digestible phosphorus levels.

Inorganic Feed Phosphates (IFP)

Vegetal feed materials do contain low and variable P-levels and above all have a too low digestibility to satisfy the animal's need for phosphorus. Most of the P found in these materials is bound as phytate phosphorus, which is virtually unavailable for monogastric animals and passes unabsorbed through the animal and directly into the manure. IFP's are used, therefore, to balance animal feeds in view of their P-content.

A wide choice of inorganic feed phosphates is available to livestock producers and feed manufacturers in Europe today[4]. The most commonly used forms of feed phosphates are monocalcium (MCP), monodicalcium (MDCP), anhydrate and dihydrate dicalcium phosphates

[3] DP% Pigs = (Pi-Pf)/Pi; dP% poultry = (Pi-(Pf+pu))/Pi
[4] Commission Directive 98/67/EC part B 11 (non exclusive list)

($DCP.0H_2O$/ $DCP.2H_2O$) and to a lesser extent magnesium phosphate (MgP), monoammonium phosphate (MAP) and monosodium phosphate (MSP).

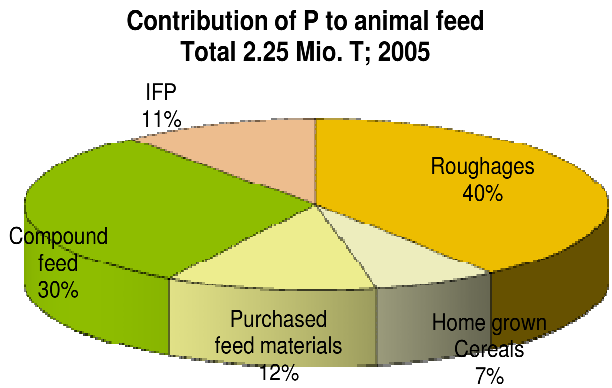

Figure 3.

Also available, although not produced in the EU is defluorinated phosphate (DFP), sometimes wrongly referred to as calcium sodium phosphate (CaNaP).
The total use of IFP is estimated to reach 1.4 mln t[5] for the EU or 0.25 mln t expressed in P, which is almost 11% of the total P consumed by livestock via feed materials (see figure 3)

Differences in P digestibility

Differences in P-digestibility in the various feed materials are well known and documented. By definition P-content and P-digestibility of plant material is low and variable (see figure 4). Also there are differences in term of P utilisation between different animals species (pigs, poultry, ruminants) (figure 5) .

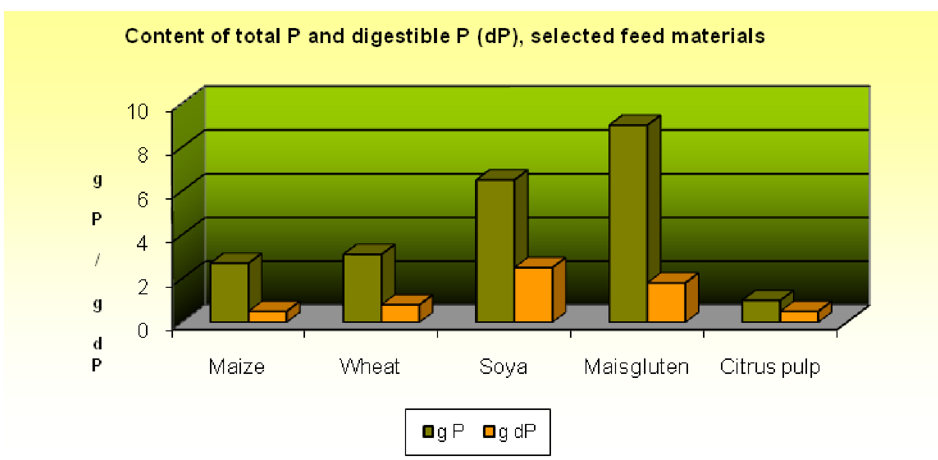

Figure 4:

[5] Cefic/IFP estimation 2006, expressed in DCP 18 equivalence

In comparison, to plant materials, IFP have both a high total P- and digestible P-content. However, differences exists also between the different IFP sources, more specifically with respect to their mineral content and chemical composition and consequently with regard to their P-digestibility. Average digestibility values are tabled for these products, to be used as a guideline for nutritionists in formulations (Table 2).

Table 2 Example of the range in P-content and bioavailability found within IFP sources

Phosphate source	*Total g P/kg*	*Pigs; digestibility %*	*Poultry; digestibility %*
MSP	*225*	*89*	*91*
MCP	*226-229*	*80-90*	*76-85*
MDCP	*213-219*	*75-80*	*81-83*
DCP (DCPa)	*182-201*	*65-72*	*55-73*
DCP.2H2O (DCPd)	*182*	*80*	*80*
DFP/CaNaP	*181*	*60*	*55*

ID-DLO, Netherlands 2001, 1996, Van der Klis & Versteegh 1996. Kemira-GrowHow AB., Tessenderlo Group

In vivo trials consistently shows that with regard to the inorganic feed phosphates, the ranking in terms of bioavailability (expressed as digestible P) for both pigs and poultry is as follows: MSP, MAP and high quality MCP's have by far the highest availability, followed by MDCP and DCP dihydrate (DCPd). With some types of DCP anhydrate (DCPa) and DFP having the lowest value (figure 5). The use of more digestible feed materials including IFP sources can contribute to the reduction of P-excretion and therefore benefits the environment. In case of ruminants, the differences in P-availability of the different IFP are less pronounced[6].

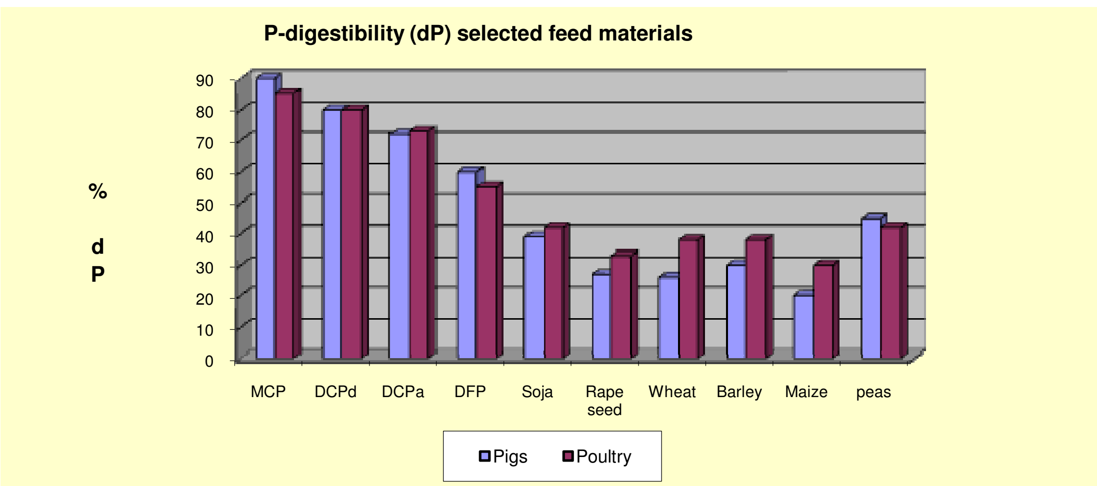

Figure 5

[6] Guéguen, 1970, in: A guide to feed phosphates, CEFIC/IFP, 1999

Phosphorus requirements:

Phosphorus requirements for animals.

Animals do have a basic requirement for phosphorus (P) to meet their needs for normal growth, skeleton formation, and the maintenance of metabolic processes (table 3). Dietary standards or phosphorus requirements for most animal species have been established. However, the requirement for P is related to the physiological status of the animal, e.g. age, production, animal species, bred and the composition of the feed material , i.e. the phosphorus digestibility. Modern agriculture production requires high performing animals, and high yielding animals evidently require a higher level of phosphorus. Deficiency can impair animal health and welfare and also can have significant economic consequences to the livestock producer.

Table 3: General phosphorus requirements for monogastric animals

	% Digestible P in feed		% Available P in feed
Pigs		***Poultry***	
Piglets	0.4	***Broilers***	0.45 – 0.35
Fattening Pigs		***Layers***	0.35 – 0.30
< 50 kg	0.3	***Chicks***	0.40 – 0.35
50 – 100 kg	0.24	***Pullets***	0.3
sows		***Turkeys***	
lactating	0.32	***Fattening***	0.5
pregnant	0.25	***breeders***	0.35

Source: A guide to feed phosphates, CEFIC/IFP, 1999

Phosphorus requirements for plants

Crops have a basic requirement for phosphorus (and nitrogen). Plant roots take up mineral nutrient as ions e.g. $H2PO_4^{-}$, and NH_4^{+} irrespective of whether it originated in manures, compost or mineral fertilisers. Since animal manure is a valuable nutrient source it is used to supply crops with nutrients, generally based on the crops' nitrogen requirements. Due to the fact that the nitrogen to phosphorous ratio in manure is not in balance with the plant/crop needs, this often leads to a surplus and accumulation of phosphorus in soils, if a proper manure, soil and fertiliser system are not applied. Therefore, next to the use of livestock manure, a number of P-containing fertilizers are used to supply the soil and thereby the plant with sufficient levels of P. Plants are incapable of fully utilising the minerals of both livestock manure and fertilisers, and it is therefore inevitable that minerals losses (N, P, K) will appear. In case of P, with its low mobility, this will largely accumulate in the soil, which is beneficial for the fertility of the soil and successive crops. On average the removal of P by crops at harvest is around 20 kg P per hectare[7]

[7] Phosphorus Balance in European Agriculture – Status and Policy options; Sibbesen, E. and A. Runge-Metzger. In: SCOPE 54, 1996.

P in livestock manure:

The production of animal manure is an inevitable result of livestock production and consequently phosphorus excretion follows as an inevitable consequence of manure production. Phosphorus excretion is the result of normal metabolic processes, the low intrinsic P-digestibility in the diet (plant materials) and because animals sometimes are fed in excess of their P-requirements.
In total almost 1.6 million t of P is excreted in the manure within EU[8]. In general, ruminants contribute around 50%, pigs 29%, and poultry 16% to the total P in livestock manure (see figure 6).

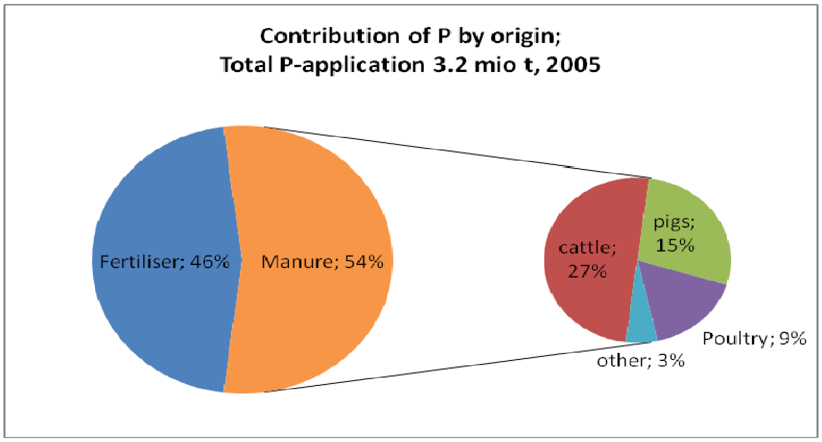

Figure 6.

The contribution of IFP to the P content in manure
Taking in account the IFP consumption per species, the digestibility of IFP and the livestock numbers within the EU, an estimation of the IFP contribution to the total P (of each specie and in total) in the manure can be calculated.
The average digestibility of the IFP sources used in swine diets is 80 % in ruminant diets 70 %, and poultry diets 70 % (see also table 2 and figure 5). The contribution of IFP sources in the EU is therefore calculated at about 74 kt P in the manure[89]. This amounts to approximately 4,6 % of the total P in the manure (see figure 7).

[8] CEH, 2004 Marketing research report, Animal Feeds : Phosphate Supplement, - SRI consulting
[9] Cefic/IFP estimation 2005, expressed in DCP 18 equivalence; dP for IFP calculated as 0,7%

	Kt
IFP used in animal feed (expressed in DCP18 eq,	1.373
P used in animal feed via IFP (eq. DCP18)	247
P unabsorbed (70% dP)and voided in manure	74
P total amount in manure	1.603
P IFP / P manure	4.6%

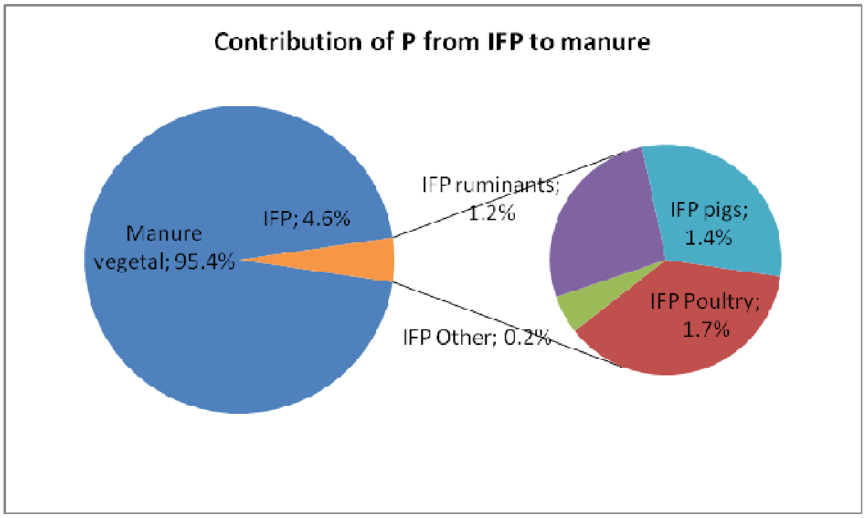

Figure 7.

P in mineral fertilizers:

In order to fulfil the mineral requirements of plants, mineral fertilizers are ideally used to balance livestock manure. The amount of mineral fertiliser added to the arable land in the EU25 in 2005 amounts to about 3,2 mln t P_2O_5 [10] which is 1,4 kt P.

P from other sources:

Livestock manure and mineral fertilisers are by far the major contributors to P in the soil. Other nutrient sources of P used in the EU agricultural area includes, sewage, food processing waste, household waste, waste from the paper, leather and meat industry etc. An estimated 0,18 mln t of P is added to the soil by other organic sources.

Current status of P to the soil:

The total P application to the soil amounts to an estimated 7.2mio t P_2O_5[11] or to 3.2 mln t of P. As mentioned the P is supplied to the soil either in the form of livestock manure (51%), as mineral fertilizer (43%) or as organic waste (6%).The total fertilised agricultural area in the EU25 is 133 million ha[12]. The total P application to the soil from these 3 sources is therefore calculated as 24 kg of P on average per ha. On average the removal of P by crops at harvest is around 20 kg P per hectare[13].

[10] EFMA leaflet : Forecast of Food, Farming and fertiliser use in the European Union 2006-2016, 2006.
[11] EFMA , 2004. Non-fertilizer nutrient sources in Europe. ECOPT report, Suffolk, UK, P 54
[12] EFMA leaflet : Forecast of Food, Farming and fertiliser use in the European Union 2006-2016, 2006
[13] Phosphorus Balance in European Agriculture – Status and Policy options; Sibbesen, E. and A. Runge-Metzger. In: SCOPE 54, 1996.

Mineral recycling:

Intensive animal production is characterised by high animal densities and high levels of plant production. As a by-product of livestock production manure is produced. Normally manure is applied to fertilise the soil for the production of crops, which later are fed partly to the animals. If correctly applied and next to the use of mineral fertilisers to balance the mineral needs of crops, manure is a perfect tool to recycle the surplus of minerals in animal feeds. Traditionally, manure has always offered a cheap, natural source also of P. But when the supply of P exceeds plant growth requirements, the excess P will accumulate in the soil (from were it can be used by successive crops) and later can enter water systems through run-off and soil erosion. Therefore, measurements should be in place to apply manure correctly (also mineral fertilisers), like sufficient storage capacity, better synchronisation with crop growth cycles and more ecological application techniques to limit run-off into surface water.

P contribution of IFP to the soil in perspective:

As indicated in figure 3 the contribution of P from IFP to animal feed amounts to 11% of a total P-content of 2.25 mln t in animal feed. Phosphorus excretion is an inevitable consequence of livestock production. Due to the high digestibility of IFP sources, the contribution of P from IFP represents only 4.6% in the manure the balance, 95.4%, is P originating from the other feed materials in the diets (figure 7).
The total P application per hectare (livestock manure, organic waste and mineral fertilisers is about 24kg per ha. In relation to this the contribution of IFP is 2,3% or 0.56 kg/ha/y of the total P-application (see figure 8)[14].

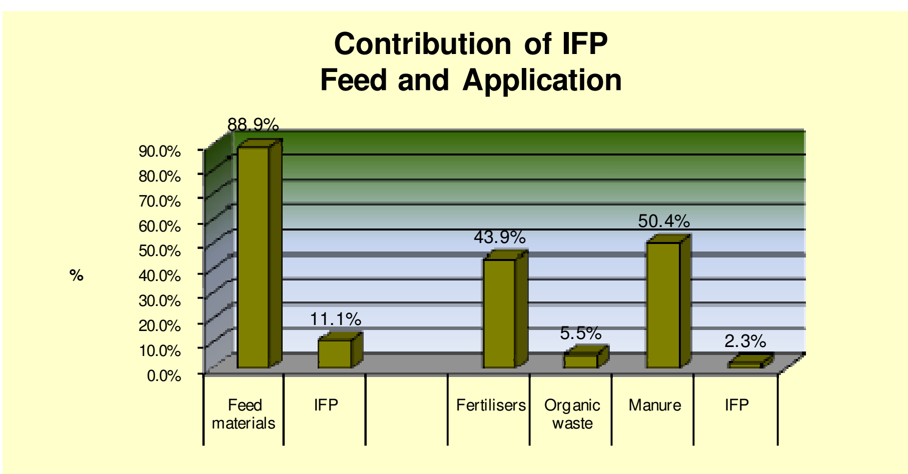

Figure 8:

[14] Calculated on dP 70% for IFP and CEFIC/IFP estimation, 2005

Individual countries:

Most European countries have national programs and projects on reducing phosphorus losses from agricultural sources to the environment. Good agricultural practices and nutrient management principles for both crop and animal production have been developed. There is however a wide variety among European countries with regard to activities and programs and with regard to the implementation and interpretation of nutritional management. In some countries this is regulated by law or voluntary measurements but generally include guidelines and recommendations on nutrient management plans. Different approaches and farming practices exists in different countries, and although most of these programs have been developed in the framework of the EU, it is necessary to look at the individual countries IFP usage and animal species distribution.

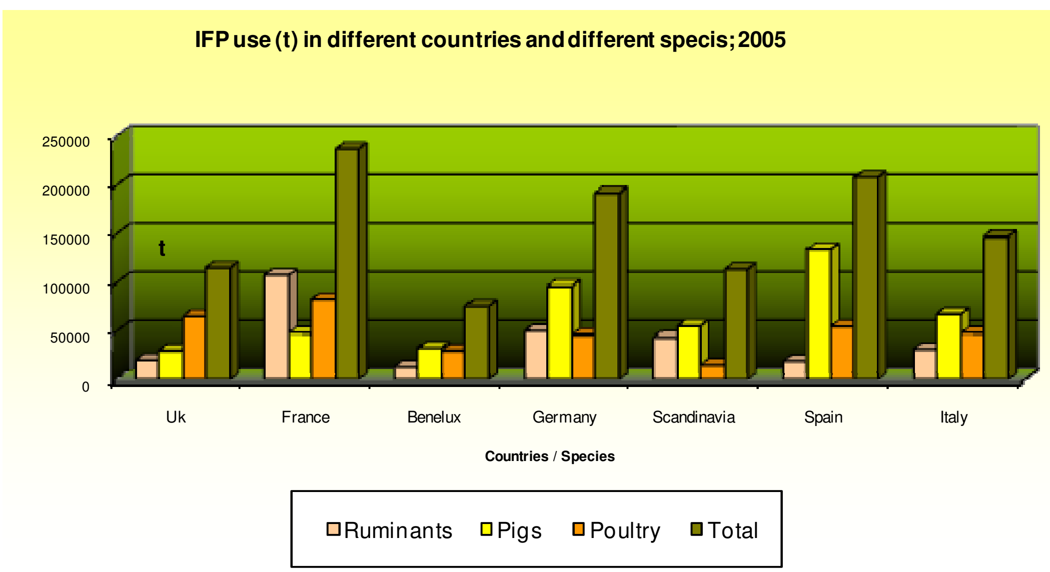

Figure 9:

Apart from France, where ruminants seem to be the biggest users of the IFP-P, pigs generally are the biggest consumers of IFP in the individual countries (Figure 9, absolute terms). This is likewise reflected in the P excretion coming from IFP (Figure 10).

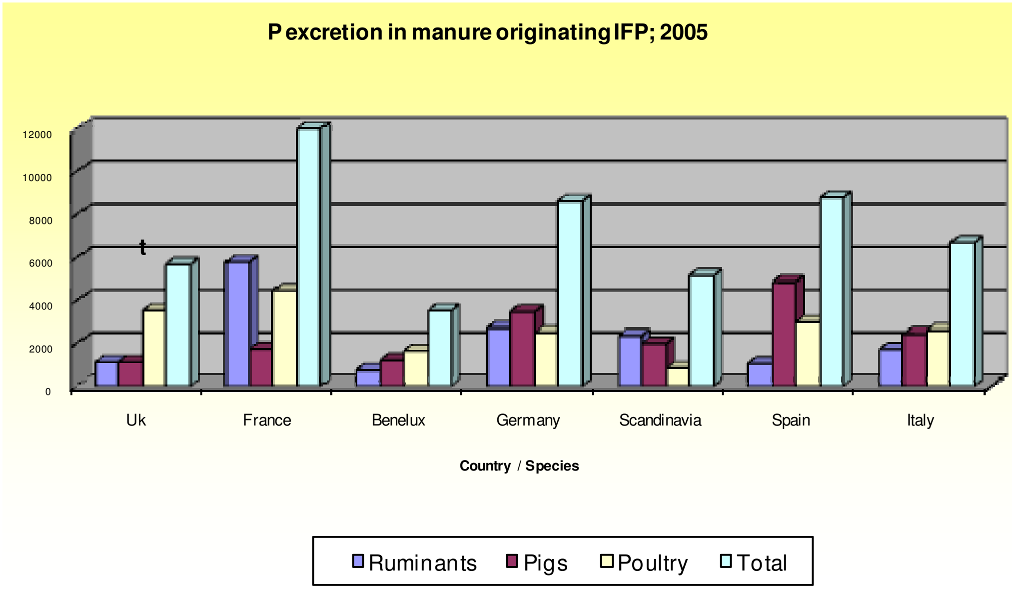

Figure 10:

Possible scenario's to limit P-excretion in livestock manure:

Environmental awareness and concerns for natural resources is the driving force for reducing the P excretion in the manure. Over the last decade considerable improvement has been seen in the efforts to reduce P excretion. These efforts involved all sectors and includes nutritional management, manure management and fertiliser management. However review on phosphorus efficiency reveals that are further potential for the reduction of P excretion in livestock manure.

Nutritional strategies

The contribution of IFP's to the P content the manure is very small; 4.6%. Despite this the use of IFP is under scrutiny in several area's because of the misconception under environmentalist or decision makers on the importance in P-excretion from IFP's. Phosphorus is essential for optimal and economical livestock production and health but every possibilities to reduce its contribution even further, should be exploited. This includes the lower use of IFP (by legislation) by fixing possible max levels, to lower the P norms to which feed are formulated, or to increase the dP level in the IFP's used. An other way is for the EU to become more self-sufficient in production of feed materials and rely less on imports.

Fixing max levels of P

There are two ways to set maximum levels on the use of feed phosphates: by limiting the use as such or to fix max levels of the total P content in the feed. There are not many alternatives to replace IFP's: the use of feed materials with a high ration dP / tP or the more use of the enzyme phytase. One of the feed materials, which can replace partly IFP, is fishmeal, having in general a P-content of 2.5% and a dP level of around 70% depending on the origin. However, some disadvantages are coupled to the use of fishmeal: it is produced from fish catches being a limited

resource, therefore, it will increase the price of animal feed. The P-digestibility is lower than in case with high digestible IFP's, therefore, P-excretion via livestock manure will not go down, and even the N-excretion via livestock manure could increase.
Increased use of phytase is generally highly unlikely because in most countries phytase is already used and because of limitations (functional and technological) in the use of phytase. Phytase is not able to release P to the full from phytate phosphorus and it can't withstand the harsh conditions (temperature, pressure) of pelleting thereby loosing its activity[15].

Increasing dP level in IFP

Although the contribution of IFP in the manure is only 4,6%, Changing the IFP source in diets to a more digestible source (e.g. DFP or low quality DCP0H2O to MCP or DCP.2H2O) in case of monogastric animals can make an impact on the excretion in several countries. However, not in all countries. In areas/countries like Scandinavia, the Benelux and even France there is no use or a small use of low quality IFP like DFP and DCP.0H2O for monogastric animals, the majority of feed phosphates used are MCP or DCP.2H2O. Therefore, no gain is to be expected from a forced change by legislation from low quality feed phosphates into high quality feed phosphates. A country in which a forced change could make difference is for example Germany. In this country there is still an important use of DFP for poultry, approximately 40.000 t. Changing from DFP into higher digestible MCP could make a possible saving to the P excretion in the manure of almost 2.500 t of P/y[16].

Decreasing P norms

P-requirements have been set for all animal categories. Over the years the requirements have been lowered down to a level that it is questionable if under practical circumstances the P-requirement for the animal is always satisfied. This is because of natural variation in nutrient content of the feed materials. Also in case of P there are major variations in content and therefore in the past a safety margin was normally included in diet formulations. Today these safety margins have been lowered or even omitted and it has significantly increased the risk of under supplying animals with adequate amount of P. This could have a negative effect on animal productivity (feed efficiency) and animal welfare. Care should be taken at all times however to reduce over-supplementation and over feeding of especially cattle.

Decrease imports of feed materials

Part of the purchased feed materials (at the farm, mostly protein rich products) and feed materials for the production of compound feed are imported from countries outside the EU and total's almost 42.5 mln t[17].

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[15] CEFIC/IFP, Considerations on the use of microbial phytase, 2006
[16] 40.000 t of DFP = 7.200 t P, containing 18% with a dP% of 50% results in an P-excretion of 2.500. The use of MCP containing 22.7% P with a dP% of 85% to supply the same level of dP results in only 700 t P-excretion.
[17] EU-25, Fefac Feed&Food Statistical Yearbook 2005

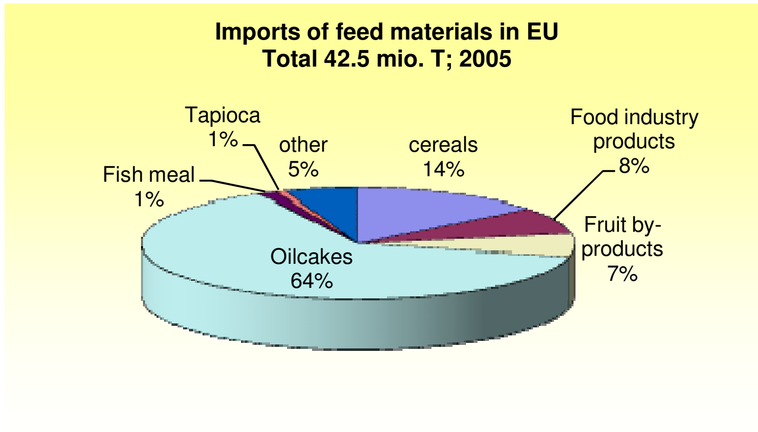

Figure 11:

Based on the P content of these feed materials the contribution of P in animal feed is with 241 kt around 10% (figure 11).

Standardizing of P-digestibility trials

According to the reference document "Best available Techniques for intensive rearing of poultry and Pigs." of the European Commission (July 2003) one of the recommended ways of reducing the excretion of phosphorus, without endangering animal health and production is the use of diets containing highly digestible inorganic feed phosphate

There is however no definition for highly digestible inorganic feed phosphate given. Therefore, standardized test should be developed for retrieving P-digestible values. And only IFP's checked according to this method should be allowed to be used in animal nutrition.

It is therefore advised to develop such method within the framework of one of the projects of DG-research. The setting of benchmark values is essential to further optimize the use of IFP. Suggested benchmark values to be used for feed phosphate should be more than 80% both in case of pigs and poultry. For ruminants the indication of a P-solubility in 2% citric acid of more than 95% should be sufficient. Which is the standard quality rule applied by the CEFIC sector group IFP[18]. By doing this the contribution of P from IFP's to livestock manure will be further optimized.

In parallel care should be taken that also the other feed materials are selected on their positive ratio dP / tP content, here an even bigger gain can be made than in case of IFP's.

Phytase

The use of commercial phytase have been shown to successfully increase the digestibility of phosphate in feed material and consequently reduces the amount of inorganic phosphorus added to the feed. The increasing use of phytase is also driven by regulatory frameworks and the implementation of Best Management Practices and Best Available techniques. It is estimated

[18] A guide to feed phosphates, CEFIC/IFP, 1999

that around 50 – 60 % of pig and poultry feed in the EU 25 is supplemented with Phytase (Steen, 2006). This however differs from country to country and is also subject to price pressure from IFPs. In selected countries up to 90 % of monogastric feed contain phytase. Although the increase of phytase is driven and supported as one of the major methods to reduce P reduction there are some unclarified areas. It is suggested that phytase might not become totally digested in the GI track. This implies that the phytase enzyme continues to hydrolyse the phytate phosphorus in the manure, and thus adding to the fraction of soluble P in the manure. This issue has received very little attention and should be investigated.

Manure management:

An effective manure management plan as suggested by EFMA , 2007, should be encouraged by European countries. Apart from storage, nutrient analyses, transport and manure spreading techniques, focus has also been placed on P recovery from manure.
Manure treatment techniques involve: Biological treatment of manure, dephosphorisation, crystallization, precipitation, separation, and incineration. Some countries practice fermentation of manure for the production of Biogas. This process mineralize nitrogen and phosphorus, which becomes more available. Other bio-energy plants incinerate manure (poultry), which results in the removal of the organic matter leaving the minerals such as phosphorus as part of the ash, to be used as fertiliser. This option as a method to remove phosphorous from the phosphorus cycle has not been shown to make a significant difference.

Nutrient management and recycling of animal manure
Animal manure is a valuable nutrient source and can be efficiently applied on agricultural land to supply crops with nutrients. Up to 70 % of manure phosphate is in inorganic form and the remaining organic part is easily decomposed by soil microorganisms to an inorganic part. Because more than 85% of the P in livestock manure is available for uptake by plants, phosphorus from livestock manure has almost the same fertilising properties as mineral fertilisers. The nutrients in manure originates from forage grown on the farm and from imported feeds and it is important that they are recycled effectively. The recycling of manure benefits the farmer economically and minimises losses of nutrients to the environment. However, the ratio between nitrogen and phosphorus as present in manure, is not in balance with the needs of crops and manure application to land is based on the crops 's nitrogen need. If a proper manure management plan and integrated nutrient management is not applied, this could lead to a phosphorus surplus and accumulation in the soil.

Integrated nutrient management
An integrated approach is a concept based on all all aspects of farm management, including soil, wider environment, animal health and welfare, manures and fertilisers and is supported by both the fertiliser and the livestock industry.
The nutrients in manures may be retained on the farm and their application needs therefore be integrated with that of mineral fertilisers. The total and available nutrient contents of manures can be measured or estimated so that balancing fertiliser requirements can be calculated. In cases where livestock numbers are too high, manure is transported to other farms which have

mainly arable cropping. Apart from correct estimations of their nutrient content, appropriate timing and spreading techniques are essential to avoid losses and to improve recovery by crops. Detailed recommendations are available with regard to manure analyses, manure storage and spreading and various technical solutions to improve the utilisation of manure (EFMA 2007)[19].

Standards
Fertiliser recommendations for manure applications exist and do differ from country to country. These data are based on different data sets and can often show large differences. In France, with regard to pig manure data are based on 2003 standards, in the UK on 2000 statistic for all manure. It is especially in terms of the national standards in fertiliser recommendations regarding grower finisher pigs that large differences are found. E.g. The amount of P excreted by a grower – finisher pig per kg live weight differs from country to country; UK 15,7, Sweden 9,6, Denmark 8,9, France, 8,8 and the Netherlands 6,5 kg P[20]. It can be assumed that these standards are higher than the actual situation and that the phytase inclusions have not been taken into account.

Summary:

The objective of this document was to put the perspective which IFP makes to the P in the manure in perspective. Livestock manure makes the biggest contribution to the P in the soil. However livestock production is an essential element in the production of basic food supply and therefore the solution lies in finding common grounds and sharing problem and solutions. Cross sector and multi – disciplinary cooperation and development is essential. With regard to IFP in specific, the use of IFP in feed due to its high p digestibility contributes to a small part of the total P excretion in the manure and thus to the P-application to the soil. From the data available, it is clear that although it is inevitable that IFP sources contributes to the total P excretion in the manure, it is only 2,3% (or 0.56 kg) of the total P application of 24kg/ha/y. This contribution can be even further reduced by standardising P digestibility values for feed materials and encouraging the use of highly digestible IFP sources. Further more utritional strategies should be more closely integrated with integrated agricultural management. The solution lies not in finding agricultural culprits but finding cross –sector solution and setting proper requirements, methodology, selected criterion and terminology.

[19] Sustaining fertile soils and productive agriculture. EFMA, 2007
[20] Phosphorus for livestock: requirements, efficient use and excretion; Steen, I.E. In: Proceedings 594, The International Fertiliser Society Conference, 2006.

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