Our Nutrient World

The challenge to produce more food & energy with less pollution.

NUTRIENT STEWARDSHIP

A key thematic issue for RIO + 20

LAGRANGE

RIO+20 United Nations Conference on Sustainable Development

Rio de Janeiro, Brazil • June 2012

The importance of a "Nutrient Administration" as a key thematic issue : the case of phosphorus

SUMMARY

Phosphorus is a vital and irreplaceable resource to the agricultural production and therefore is an inseparable issue at the nexus **food-water-energy**. As we know its non-renewable reserves are decreasing in quantity and quality making it considered as a planetary boundary to human kind. Presently, phosphate demand has become another factor leading to global food inflation by forcing up fertilizers prices beside energy costs. In the long run, phosphate reserves will be completely depleted. Despite of its importance for crops production, phosphorus has been used wastefully for a century. Taking care about the phosphorus issue, is of strategic importance to food security while a key factor controlling water pollution with its multiple consequences. Thus , it is of paramount relevance to devise policies worldwide to close the bio-geo-economic flux of phosphorus and other vital nutrients. Maintenance of global food security will require a wise stewardship in different ways. Strategic investments on nutrient resources as phosphorus and potassium must be among them. Taking into account the relevance of this theme, we support the initiative to include the **nutrient stewardship** beside the issues food , water and energy. Indeed, this a more one valuable tool for ensure the pillars of sustainable development while providing synergic solutions.

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1 - Placement of the phosphorus related issues

1.A)- DEMAND, PRICES AND INFLATION

Phosphorus is a non-renewable essential component of fertilizers that render possible the production of food on a large scale. Like other non-renewable resources phosphorus can be considered a planetary limiting factor for human kind. While world population has grown 4,4 times from 1900 to 2011, phosphate ore mining increased beyond 50 times during the same period (Moreira,2010). Today, more than 80% of the world's known phosphate rock reserves lie in Morocco, China , South Africa and Jordan (Jasinski, 2008). It is recognized that the geological reserves of high degree are dwindling which, beside other factors such as fossil fuel prices, have led to increased costs of this commodity in the world market as depicted in **Figure 1**. In fact, the rising price of phosphate has come to be one more factor that led to food inflation.

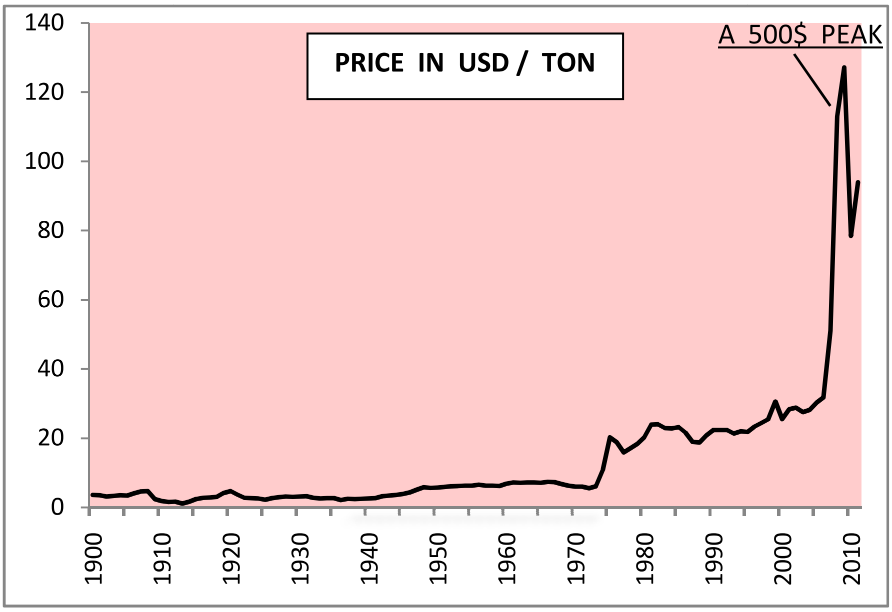

Figure 1- Average prices of phosphate rock per metric ton since 1900. During the 2008 economic crisis phosphate prices spiked beyond 500 USD. Primary data from USGS.

Thereafter of the beginning of 2007-8 economic crisis, phosphate rock and fertilizers prices spiked to a records as never seen. As a result, it has been more one remarkable determinant for the spread of hunger in the world given the fact that there is much lack of soil fertility in less-favored regions. This was already a *phosphate crisis* for the less developed nations which lack financial possibilities to buy fertilizers and grains. For the rest of the world it can be considered as a preamble for other surges in food inflation, with its subsidiary consequences to the all economies. This is remarkable to place that from this last surge are not a transient peak: this really represents a establishment of a new high level of phosphate prices even much greater than occurred in 1973 oil crisis. It is possible that mining and production of refined phosphate will increase substantially ahead. Yet, the general trend is the gradual tightening between production and consumption of phosphate as depicted in **Figure 2**.

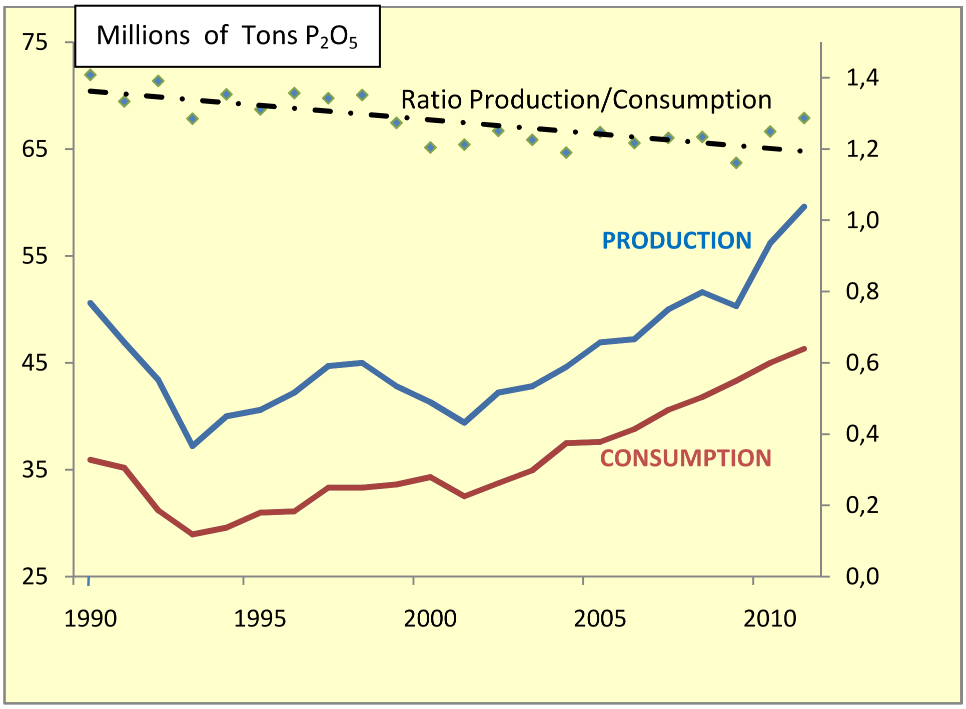

Figure 2- General trend of production and consumption of phosphate in the past 22 years expressed as million tons of P_2O_5. The average ratio Production / Consumption is represented by a linear regression which show a steady decreasing during this period (P/C = -0,006x + 14,59 R^2 = 0,445). Primary data from USGS, IFA and Fertecon Co.

Although being a hypothetical linear regression, this graph can be usable to make some comparisons. The theoretical point where production equals to consumption (P/C = 1) would be achieved by circa the year 2265 if production could grow at same constant rate in 250 years. In order to have a margin of separation between production and demand similar to the current one by **2043** it would require an increase in production to about 80 million tons P_2O_5. For that, besides the increased production, the rate of phosphate consumption per capita would have to remain approximately constant over the coming decades. However, this last prognostic may not be achieved, considering the recent patterns of increased consumption. The International Fertilizer Industry Association (IFA) had early forecasted a 2,7% increase of phosphate fertilizer consumption for the period between 2003 and 2008 (IFA, 2004). Notwithstanding, according later reports the annual rate registered from 2006 to 2008 reached 4,2%, a 1.56 times higher than the predicted rates which corresponded to more 4,7 million tonnes of P_2O_5 per year. It was the equivalent of adding another USA to world phosphate consumption in less than three years (Mosaic, 2009). The two main factors which enhanced the phosphate demand from this period were: (*i*) the improvement of dietary standards in the emerging economies and (*ii*) the rapid expansion of monocultures to supply biofuels production (FAO, 2008a; ECJRC ,2008; Huang, 2009). Some reports says that phosphate reserves are sufficient to meet demand for many decades, assuming current rates of use (Cisse & Mrabet, 2004; IFDC, 2008). However,_this matter can not be viewed as the duration of gasoline in a car which only stop when the fuel runs out. It is important to note that problems derived of phosphate supply not starts just when geological reserves will be nearing the end. Phosphorus products are becoming more costly every year not due to the an overall scarcity it self but because reserves of high grade phosphate ore are dwindling, leading to exploit the lower grade reserves whose mining and processing are more expensive.

On the other hand, phosphate provision depends also about how fast it can be supplied to cope with the intense consumption. Because these resources are not rapidly available given of the huge demand, large investments are required to access, develop (Heffer & Prud'homme, 2008) and distribute phosphate fertilizers from the existing mineral reserves. A minimum of seven years at least, is needed from the opening of a phosphate mine until complete the construction of a fertilizer factory. Moreover, the extraction capacity has its own maximum limits. The entire process to supply phosphate is very time consuming since the extraction from mines, till its refine and processing. Although there are phosphate ore enough for many generations, it is possible occur situations of shortage in some regions due the lack of financial capabilities to access. Unequivocally, the world is entering a phase of continuous rise and volatility of food prices while demand is growing closer to the stockpiles. In this context, increasing of phosphate fertilizers prices will follow becoming one more relevant factor to push up food inflation around the world to the next decades.

2.B)-HOW PHOSPHORUS ISSUES ARE LINKED TO RIO+20 THEMES

The exploration and use of phosphates is characterized by a linear system with copious and irreversible final disposal into waters and landfils, causing eutrophication of the seas and inland waters. As a widespread form of pollution, eutrophication has several subsidiary consequences as the formation of ***dead zones*** in many regions harming marine biodiversity and fisheries while also determines unsanitary conditions for the population on land and in coastal environments. **Our estimates based on various data sources, suggest that the overall economic losses caused by eutrophication around 80 billion dollars per year**. Indeed, issues related to phosphorus are linked to themes and sub-themes relevant areas on food production, economics and pollution control as is shown in the checklist bellow.

→ Access to food / food security

→ Inflation caused by increase of the prices of food commodities.

→ Spreading of pollution and *dead zones* affecting :

Biodiversity and biological resources

Sanitary conditions / public health

Quality of drinking water and other water resources

Various economic activities linked to water uses and aquatic environments.

Appearing of certain sources of methane and other *greenhouse gases* caused by eutrophication and careless use of nutrients.

Thus, we can see that phosphates can interfere in different ways with important issues raised in RIO +20 Conference, which are represented schematically in **Figure 3** below.

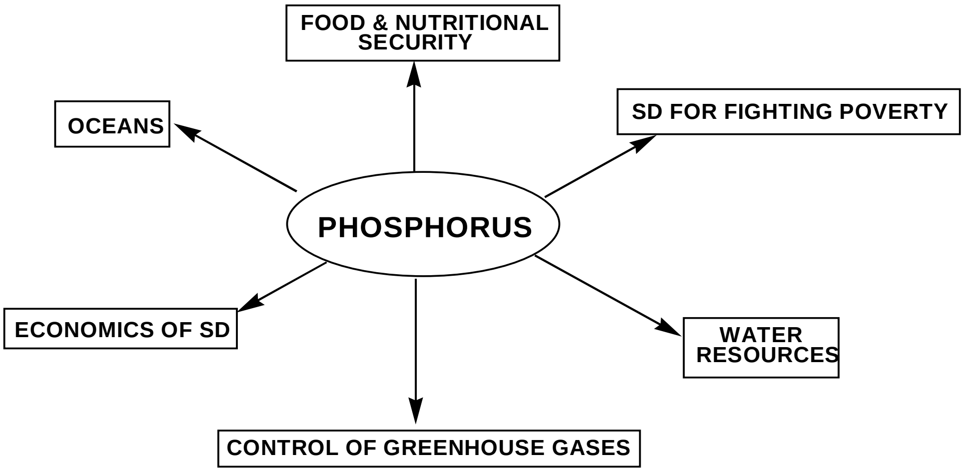

Figure 3 - The flux of phosphorus in the anthroposphere impacts several aspects of sustainability.

Considering the role of phosphorus in various topics related to sustainability follows the importance of having controls that enable close the biogeochemical flux of this element in anthroposphere and thus maintain positive results in terms of preservation of nutritional resources while focusing on environmental conservation. If there were an administration on nutritional resources made from an integral vision, it would be possible to solve many issues regarding the increasing use of phosphorus for food production. This does not imply to don't have sectors of administration, but to create a consolidation to address these issues efficiently. As the disposing of waste phosphorus to the environment causes a lot of problems, otherwise the rationalization of its use (in a number of ways) will offer several solutions to environmental and economic levels, whereas food is an item that affects the economy.

2-Recommendations

A)- ABOUT "NUTRIENT ADMINISTRATION "

As suggested above, our thinking is focused on the usefulness of establishing an integrated model (or models), of " NUTRIENT ADMINISTRATION ". We have observed that in recent decades the thematic on phosphorus fertilizers is often technically single minded and administered under different perspectives, sometimes conflicting and slanted.

Here we introduce explicitly the concept of NUTRIENT ADMINISTRATION as: ***"a form of integrated management that allows the rational use of nutrients through practices closer to sustainability, ensuring the productivity of food and the pollution control while also helping to ensure strategic reserves of nutrients like phosphorus for future generations ".*** The essential feature of this approach is to provide a full view of the multiple effects related to nutrient issues, so as not to leave gaps. The basic geographical unit to practice the administration of nutrients are the drainage basins belong agricultural areas, natural environments or cities. But it can also involve the surrounds of the mines and phosphate industries. Primary promoters should be agents of government, one acting as controller and by means of technical extension and also aided by entrepreneurs and civil society.

In practical terms, the administration of nutrients should provide: (i) a set of regulatory standards regarding the use and the escape of nutrients by rivers and drainage (ii) fostering "best practices" [i.e. more efficient use of fertilizers], (iii) promotion of nutrients recycling from residues as much as possible, (iv) establishment of policies against food wasting and nutrients at various levels [according to the FAO reports almost one third of food produced annually is wasted]. Although most of residues with nutrient content have been seen for a long time as discarding material, in fact it represents an enormous and irreversible continuous waste of vital elements such as phosphorus.

All economic activities related to the administration of nutrients may be classified as within the general concept of the *green economy* since it contributes to prevent depletion of resources such as phosphorus, help to prevent food inflation and controlling pollution. The administration of nutrients can be practiced anywhere in the world, specifically tailored to local conditions, resulting in positive impacts in terms of pollution control, as in the development of efficient production and use of food, even in the poorest regions. At the medium and long term, the administration of nutrients also cooperate to reduce the extreme demand of phosphate fertilizer.

The concept of administration of nutrients as mentioned here, has as its basic model the line of the phosphorus usage which means a biogeochemical system subjected to anthropogenic influences, starting from the mining to the final disposal. **Figure 4** shows the schematic of the line of phosphorus utilization.

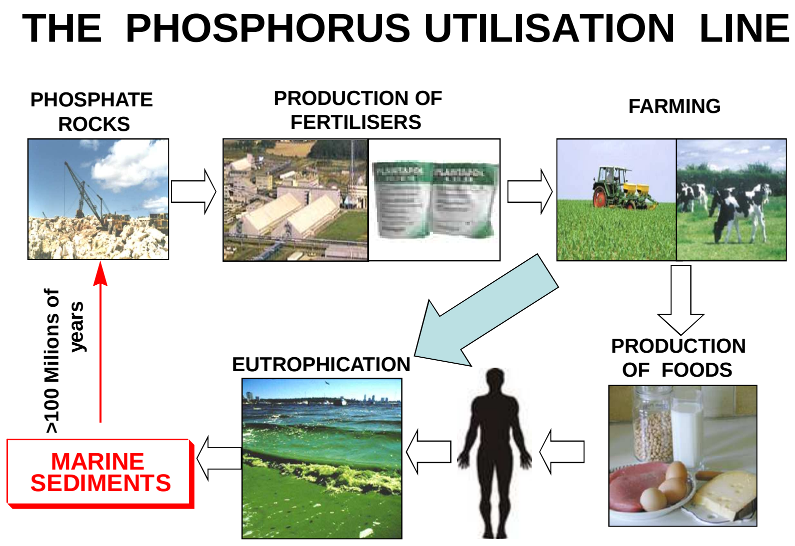

Figure 4– The line of the phosphorus usage has been characterized for a long time by the large utilization of fertilizers and a continuous discarding into environment.

Taking this model in more details, it is possible to identify the main routes of this element and devise methods to close its biogeoeconomic flux, avoiding waste and disposal to the environment. The natural cycling that leads to the formation of phosphate rock occurs in hundreds of millions of years, which makes the disposal of this element irreversible on the timescale of human civilization. Being a vital and irreplaceable, it is necessary forms prudent management, with emphasis to avoid waste and close the phosphorus cycle.

B)- NEED OF INVESTIMENTS AND SUBSIDIES

Whereas vital nutrient resources like phosphorus (i.e. potassium, nitrogen) represent a **key-sector**, investment policies are necessary to implement administration of nutrients and its practices. That would be a way to incorporate environmental costs with positive feedback enhancing sustainable development in the short and long term in a strategic area as food production associating it with pollution control. The grants may come from different sources. Among these we mention: public and private investments, specific reduction of taxes, and even also subsidies of energy tariffs. For example, is a well known fact that in many countries, certain types of industries have been granted to use electricity at lower tariffs. Similarly, the differential pricing would be an allowance for processes that could help phosphorus management and minimize wastage(e.g. taking this example, the principle of differential pricing of energy could be applied effectively to other activities promoting the ***green economy*** creating a flow of beneficial economic activities). Investments and subventions to close the phosphorus biogeoeconomic cycle will enable: **(1) preserve strategic phosphate reserves, (2) avert water pollution and its caused economic losses (3) avoid lose definitively phosphorus into the aquatic systems and landfills**. There are many opportunities for saving phosphorus along its utilization line.

C)- INNOVATION AND RESEARCH ON FOOD TECHNOLOGIES (i.e. PROTEIN PRODUCTION FROM VEGETABLES)

Long one of the major forms of protein production have been breeding. However, as we know the indefinite expansion of the livestock is a source of powerful greenhouse gases. Still, there is a loss of eco-efficiency to scavenge meat protein of animals that feed from grains. The scheme in **Figure 5** shows a hypothetical example of the loss of phosphorus along a production line animal meat for human consumption that begins with the grain production. In the adult humans, almost all the phosphorus is irreversibly excreted by urine.

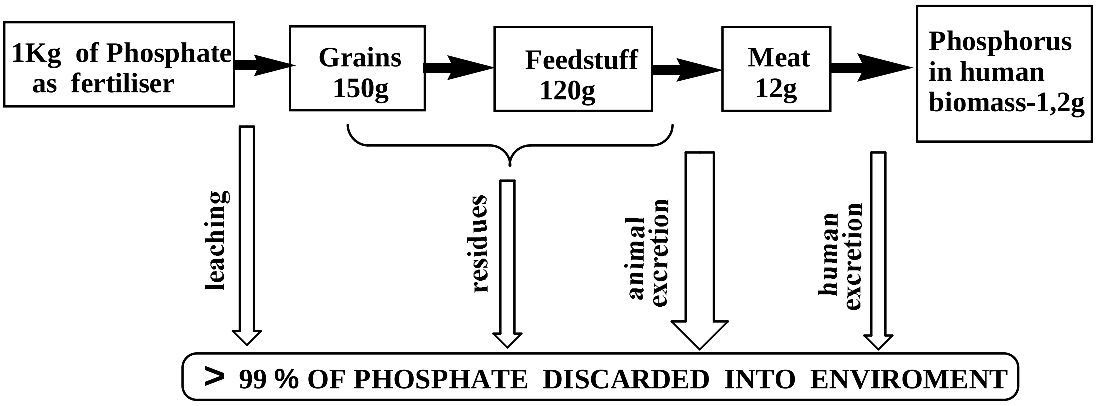

Figure 5- A hypothetical human food chain based on meat production from grains. It is assumed that conversion factor is around 1 /10.

So, in a world with more than 15 billion people the way to supply food for all will be to produce protein derived from vegetables. Protein substances of vegetable origin such as cereal meal can be used as dietary supplements on a larger scale. For example, the addition of some amounts of soybean meal and other food loaves could significantly improve the dietary patterns in different regions. On the other hand , reducing livestock population will be beneficial to decrease atmospheric methane. Furthermore, different biochemical techniques can be used to produce amino acids from vegetable biomasses, as do certain organisms for millions of years. To reduce world meat consumption, will require much effort and education for awareness since there is still a widespread dietary habits in human culture.

3) → FINAL REMARKS

Undoubtedly, the world is moving towards a phase of transition and adaptation to a populous future by making the non-renewable resources have to be managed wisely and prudently to prevent what has been called by the economist William Forster Lloyd (1883) as the "Tragedy of the Commons".

Once Vladimir Vernadsky, an ukranian geochemist, had already warned about the issue of resource exhaustion. But he believed in a vision of great optimism. In his time he proposed that we moves towards a global and historical change that will be consummated when man could control the biosphere conditions by means of the knowledge and the will in order to maintain its properties and resources.

To assume conscientiously the management of planetary resources is unavoidable task that have to be initiated as soon as possible. The management of nutritional resources (i.e. N, P and K) is of vital importance to ensure food production, economic stability and environmental conditions of water bodies, with their multiple uses. In the context of the International Conference Rio + 20, it sure is important to mind this subject more thoroughly.

“ LAGRANGE’s DRAFT ON NUTRIENTS MANAGEMENT “

About nutrients→A first draft

Nutrients

We recognize the importance of nutritive resources as phosphorus, nitrogen and potassium for ensuring crops yields and like being an inseparable issue at the nexus food-water-energy. Therefore we encourage the adoption of best practices and technologies to improve agricultural productivity whereas minimizing nutrient wastage and its discarding into environment. To do so, we call for subsidies and proper policies to close the biogeoeconomic cycle of phosphorus in the various sectors of its utilization and disposal.

We underpin the utility of implement a cross-sectoral integrated administration in order to allows the rational use of nutrients through practices closer to sustainability, ensuring the productivity of food and the pollution control while also helping to maintain strategic reserves of vital nutrients like phosphorus for future generations.

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