THE IMPORTANCE OF SINGLE SUPERPHOSPHATE FOR TROPICAL AGRICULTURE

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Introduction

Brazil is the fourth largest consumer of fertilizer in the world, with a demand of 31.08 million tons of products (13.43 mi. t. of N, P_2O_5, K_2O) in 2013 and an average market growth of 6% per year in the last 25 years. This requires large imports of manufactured fertilizer (21,62 mi. t. in 2013), as well as basic raw materials such as sulfur, rock phosphate, ammonia, sulfuric acid, and phosphoric acid. Filling this gap with domestic production is thus relevant to attend the ever-increasing demand. Phosphorus is a key nutrient for sustainable production of food, feed, fiber, and fuel worldwide, especially in tropical agroecosystems, due to the high P-fixing capacity of oxidic soils. Furthermore, low Ca content and high Al saturation are additional constrains for adequate production in tropical soils due to the limited development of the rooting system. Such drawbacks are even worse in rainfed agriculture settled in regions subjected to “veranicos” (short dry spells during the rainy season), as it happens in large portions of Brazil. Key issues in designing approaches for efficient use of P and its resources in Brazil should include agronomic as well as logistical aspects. This papers intends to stress the benefits and the importance of single super phosphate (SSP) as an efficient and environmentally friendly source of P for Brazilian agriculture, emphasizing: i) the importance of SSP as a source of P, S, and Ca, as well as a potential carrier for micronutrients; ii) its relevance for delivering an indirect effect in terms of correction of subsurface soil acidity, thus providing an improved environment for better root development and nutrient use efficiency; and, iii) the favorable spatial distribution of P resources and fertilizer plants for production of SSP and other sulfuric-acid based P fertilizers in Brazil.

Methods

Relevant data for assessing the contribution of SSP and other sulfuric-acid based P fertilizers (hereafter called SSP for simplicity) for Brazilian agriculture was gathered from statistical surveys regarding production, import, and consumption of such fertilizers, as well as from information concerning production technology/capacity and location of fertilizer plants. We also evaluated the benefits of such fertilizers vis-a-vis the available production and their positive effects on soils and crops in the tropics.

Results and discussion

Table 1 gives an overview on the availability of SSP (exports data not shown) and its relative share in total fertilizer consumption in Brazil. It is clear from this data that despite the availability and capacity to produce SSP, the market share of these products has declined in recent years in Brazil, which justifies an effort to recover SSP production and use in Brazilian agriculture in order to achieve a better use of our existing resources. Adequate spatial distribution of fertilizer production is key in a country with continental dimensions and spatially dispersed agricultural production. In Brazil, such conditions exist only for SSP, which is significant to reduce logistical costs. Figure 1 shows the spatial distribution of SSP plants in Brazil, which currently provides a total installed capacity of 8.75 million tons, an important contribution to fulfill the increasing demand of P fertilizer in Brazilian agricultural frontiers. A relevant aspect of such spatial distribution is the more efficient use of P resources, since production has been positioned close to local phosphate rock deposits or to ports of imports, targeting the markets with a focus on decreasing the distance to consumers. It is also noteworthy to stress that the Brazilian legislation recognizes alternative sulfuric-acidulated P fertilizers (other than single super phosphate) as having a similar efficiency of SSP, even if they have lower water solubility than that required for SSP production. In fact, in order to prove their agronomic efficiency, these new "superphosphates" should have a water solubility at least close to 60% of the P solubility found in neutral ammonium citrate extracting solutions. This condition increases the scope for using less noble Brazilian phosphatic rock mineral resources, which otherwise could not be used for production of phosphoric acid, making it feasible the use of natural resources that would not be adequate for economic production of high-grade fertilizers.

Another point to consider is that the dependence of imported sulfur (S), a basic raw material used in the main production chain of soluble P fertilizers, is nearly total in Brazil. Yet, the production of SSP also offers significant savings of this resource (about 20%). While the production of 1 ton of soluble P_2O_5 contained in SSP consumes 710 kg of S, the same amount of P_2O_5 as phosphoric acid would require 850 kg of S. The lower carbon footprint is also another comparative advantage of SSP, as this fertilizer emites 3 times less CO2eq/per kg of P2O5 produced than a high-grade P fertilizer as TSP (Kool et al., 2012[1]). Still from the environmental point of view, since SSP carries calcium sulphate on its composition, in addition to offering all the S used in its production, as well as soluble Ca for crop production, such fertilizers provide also a better environment for root development. This allows a better exploitation of water and nutrients from subsoil resulting in higher yields due to improved fertilizer use efficiency, which is especially relevant for N-NO_3^-. High-grade P fertilizers can not provide such benefit. Since gypsum (calcium sulphate) is widely used in agricultural areas with constrains related to Ca deficiency/Al toxicity in Brazil, this effect can be achieved by using SSP, without requiring a new operation. Finally, it is also important to highlight the possibility of adding other nutrients to SSP, such as zinc, manganese, copper, and boron, with greater agronomic efficiency due to the greater acidity generated from the dissolution of this P fertilizer, coupled to a more homogeneous application and uniform distribution in the field.

[1] http://blonkconsultants.nl/upload/pdf/PDV%20rapporten/fertilizer_production%20D03.pdf.

One of the disadvantages inaccurately mentioned in relation to the use of SSP, which is a low-grade fertilizer, is logistical costs. Nonetheless, this is significantly attenuated taking into consideration the need of gypsum in most cultivated soils in Brazil, due to its effectiveness in ameliorating subsoil acidity in highly weathered soils, as well as its role as a source of S to plants. A continuous use of SSP yields gradual but effective results in terms of subsoil ammelioration, which are similar to those obtained by the use of gypsum (Lopes et al., 2010). It also avoids imbalanced use of gypsum that could result in Mg and K leaching. In fact, when considering long term applications, the use of SSP could be advantageous when compared with the use of high-grade P fertilizers + gypsum. As shown in the figure 2, the use of 300 kg of SSP per hectare per year during 10 years will result in the consumption of 3 tons of products. On the other hand, using equivalent amounts of gypsum (found in SSP) + MAP will lead to 3.35 tons, whereas gypsum + TSP would result in 3.5 tons of products to be transported. Such figures point out that and adequate and continuous use of SSP is also economically important in a large country with a large area of agricultural production as Brazil.

Conclusions

Single super phosphate has a leading role in crop fertilization in Brazil. Besides the importance of SSP as a source of P, S, and Ca, as well as a potential carrier for micronutrients, its benefitial effect in terms of correction of subsurface soil acidity and the favorable spatial distribution of P resources and fertilizer plants for production of SSP and other sulfuric-acid based P fertilizers in Brazil reinforces the importance of such fertilizer sources for tropical agriculture.

Keywords: Superphosphate, Fertilizer Consumption, Tropical Soils

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Table 1. Single superphosphate (SSP) consumption in Brazil (tons).

Year	National production	Imports	SSP consumption	Total fertilizer consumption	SSP share (over total consumption)
	---------- tons ----------				%
2004	5,628,486	434,471	5,720,560	22,767,489	25.1
2005	4,377,809	137,069	4,566,627	22,194,731	22.6
2006	4,223,098	137,299	4,600,256	20,981,734	21.9
2007	5,363,485	364,541	5,088,810	24,608,993	20.7
2008	4,702,201	300,753	4,630,782	22,429,232	20.6
2009	4,234,954	225,391	5,165,604	22,470,821	23.0
2010	5,033,885	312,533	5,415,296	24,516,184	22.1
2011	5,476,401	612,072	5,653,815	28,326,254	20.0
2012	5,067,042	676,203	5,788,829	29,537,010	19.6
2013	4,931,306	870,782	5,525,278	29,537,010	17.8

Source: ANDA. Anuário Estatístico do Setor de Fertilizantes (2014).

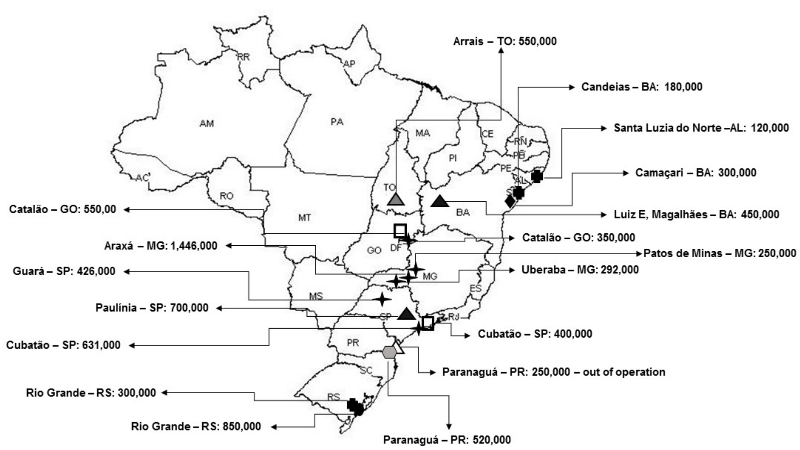

Figure 1. Installed capacity for production (tons) of SSP in Brasil (Source: ANDA)

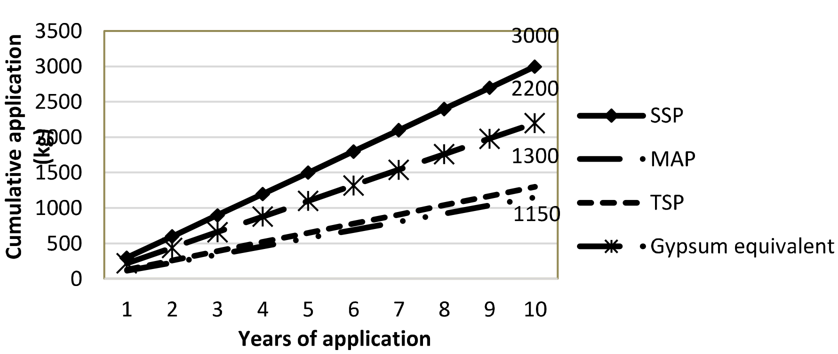

Figure 2. Cumulative quantity of MAP or TSP and gypsum (found in SSP) compared with anual use of 300 kg of SSP.