Abstract. This chapter discusses the global biogeochemical sulphur (S) cycle and pool, the role of nutrient management, and of S management, in achieving agronomic and environmental objectives. Understanding the biogeochemical cycling of S is of crucial importance for S management in agroecosystems. Sulphur is involved in reduction-oxidation reactions and thereby transformed in different species, which have different reactivity and mobility in the environment. Unlike most other nutrients, plant available S is transported both through the atmosphere and with the hydrological cycle.

Atmospheric S deposition is the single largest external source of plant available S. Crop offtake and S leaching are the largest outputs of S in agroecosystems. The S supply from internal sources, i.e. net mineralisation of soil organic matter, crop residues and animal manure, is important for the match of S supply to S demand, but difficult to predict. Because of the huge variation in both S supply and S demand, managing S in agroecosystems has to be farm, site, soil, crop, and climate specific.

Management is the single most important production factor of agroecosystems, determining the economic and environmental performances of these systems. The focus of S management in agroecosystems is on matching the S supply to the S demand, i.e. the right amount of S in the right form at the right place at the right time. These management activities have to be considered in a whole farm perspective, to be able to achieve consistency in the general farm strategy and also to achieve a balanced supply for all essential nutrients.

Simple S budget models greatly facilitate the decision support process in S management. These models calculate all S inputs and all S outputs on a daily or weekly basis and thereby are capable of predicting whether or not fertiliser S is required. So far, S fertilisers still constitute a minor source of S in agroecosystems but forecasts indicate that the use of S fertiliser will double in the next two decades.

1. INTRODUCTION

The concern of nutrient management is the application of expertise and information about nutrients in guiding decisions and actions in agroecosystem. Basically, nutrient management is a set of specialised activities aimed at manipulating the nutrient sources and transformations of the agroecosystem, so as to achieve both economic and environmental targets (Beegle et al., 2000; Oenema and Pietrzak, 2002). The activities focus on the synchronisation and synlocalisation of plant-available nutrient sources to the demand of nutrients by crops and animals, i.e. the right nutrients, in right amounts, at the right time and at the right place. Thus, the basic question in nutrient management is “how to get the right nutrients in the right amounts at the right time and at the right place?”

The term ‘nutrient management’ has become common from the early 1980s onwards, when environmental effects of the intensification of agricultural production through increased applications of fertiliser and animal manure became evident. Nutrient management emphasises that both agronomic (crop yield, quality and soil fertility) and environmental objectives with respect to resource use and nutrient losses to the wider environment need to be considered. All nutrients and their sources need to be taken into account, i.e. nutrients in soil reserves, crop residues, animal manure, wastes,
atmospheric deposition, biological nitrogen fixation, and fertilisers. Though, there are 14 nutrient elements known to be essential for plants, and 18 for animals (Follett and Wilkenson, 1995; Marschner, 1995), the focus in nutrient management often is on nitrogen (N) and phosphorus (P). These nutrients are the main yield-limiting nutrients, and the losses of these nutrients from agroecosystems have also the largest impacts on the environment (Tilman et al., 2001). Efficiency of utilisation of these nutrients in crop and animal production also depends on the availability of other nutrients (e.g. Marschner, 1995; Whitehead, 2000), and neglecting other nutrients in nutrient management can be highly counter-productive.

This chapter deals with managing sulphur (S) in agroecosystems. Sulphur is an essential nutrients for both plants and animals. Shortages and excess of S limit crop and animal productivity. Thus, sulphur needs to be managed because its supply from 'natural' sources does not always match the S demand by crops and animals. In case of short supply, S has to be added via S containing fertilisers and/or organic soil amendments. When the supply is too large, measures have to be taken to decrease the supply. Usually, farmers can easily increase the S supply by applying S fertilisers, but they have limited possibilities to decrease the S supply from 'natural' sources. Agreements between (supra)national governments and industry can decrease the S emissions into the atmosphere and thereby the atmospheric deposition of S to agroecosystems, and thereby the supply to crops and animals. Evidently, management of S requires actions from both governments and farmers (Fig 1). Actions from governments are needed especially when the atmospheric S deposition, originating from industrial sources, is too large. Actions from farmers are needed when the S supply is too small to match S demand by crops and animals, but also when the S supply is too large.

The anthropogenic influence on the global S cycle has been enormous during the last two centuries, especially in the industrialised world (Brimblecombe et al., 1989).

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**Figure 1.** Analytical framework for the management of S in agroecosystems, in dependence of the management of industrial S emissions by governments and industry.