The low concentration and low solubility of phosphorus (P) compounds in unfertilized (unmanured) soils limits land-use for continuous crop production (Hedley et al., 1995). Fertilizers and by-products (manures) containing P are applied to soils with the main purpose of increasing the bioavailable supply of orthophosphate to the roots of food and fiber-producing plants. The most commonly used P fertilizers are shown in Table 7–1. To be effective in removing the P constraint to crop growth the P compounds added to soil must raise the concentration of the orthophosphate ion in the soil solution that bathes the roots of crop plants. For P fertilizers to be effective they, or their reaction products in soil (e.g., decomposition of organic manure), must have larger solubility products than the natural phosphates already present in soils. Thus, it is no surprise to find that the conclusions from agronomic trials in many soils are that the application of the most soluble forms of P compounds (Table 7–2) results in the most rapid increases in crop yield and the largest, first-season, yield gains per unit P applied. Such trials also show, however, that only 5 to 30% of the soluble P applied to soils is recovered in the first crop (McLaughlin et al., 1988), leaving 70 to 95% of the P applied in ‘fertilizer-soil reaction products’ in the soil for the next growing season (Barrow, 1980; Bolland and Gilkes 1998). Long-term trials demonstrate that the yield-producing capability of this residual phosphate in the next season is considerably lower (by 20–70%) than that of freshly applied soluble phosphate and over a number of years continues to decline (Bolland and Gilkes 1998; see later discussion). Much of the research undertaken to identify the nature of these low solubility, fertilizer-soil reaction products was completed prior to 1980 and extensively reviewed by Sample et al. (1980) and Hofford (1989).

In this chapter, the key processes and factors influencing the type of reactions occurring and the nature of the fertilizer-soil reaction products formed are