Chapter I

Introduction

Agriculture is the main sector and it contributes approximately 40% of gross national product (GNP) of Cambodia. The total agricultural crops production area in 1999 was about 2.45 million hectares (Men *et al*., 2000). Rice is the population's staple food and, in 1999, accounted for 89% of the total agricultural production area. Rice production area significantly increased 1.4 and 1.9 million hectares in 1980 and 1990, respectively (Ouk *et al*., 2000).

In Cambodia, about 85 % of rice grown in rainfed lowland conditions (Lando and Mak, 1994a; MAFF, 2000), and where soils are mostly sandy, acidic and infertile soils (Pheav *et al*., 1996; White *et al*., 1997a, b). In these areas, farmers annually grow only one rice crop during the wet season, and the fields usually remain fallow during the dry season after harvesting rice even though the soil may be favourable for some non-rice crops which can generate better incomes (Chea *et al*., 2001). In the fallow period, soils remain dry for at least 3-4 months, and then experience intermittent wet and drying during the early wet season (2-4 months) when volunteer pasture growth occurs. In rainfed lowland ecosystems, where water supply is limited for the second rice crop, sufficient water may still be available to grow an upland crop. In most areas where two crops may be grown in one year, wet season lowland rice is the main crop and an opportunity crop may be grown in the early wet season and dry season. Short duration grain legumes such as mung bean and black gram could be successfully grown before and after wet season rice. Today, legumes account for about 5% of the gross national products in Cambodia.

Introduction of a double-cropping system into the rice-based cropping system in the coarse-textured rainfed lowlands would take advantage of the bimodal rainfall pattern and the three potential growing (early-wet, main wet and dry) seasons per year. The double-cropping system is proposed on the assumption that farmers would adopt sequential improvements to an existing system rather an entirely new system. The rice-based double cropping system would offer an alternative to farmers with

limited resources to generating extra income during the dry season or early wet season apart from increasing rice yields in the main wet season. The second crop of the double-cropping system in the dry- or early wet season could apart from increasing cash to the household: 1) provide fodder for animal grazing the pastures (Fujisaka, 1991); 2) accelerate nutrient recycling of inorganic and organic residues from previous and current crops (Roder *et al*., 1995); 3) contribute to the control of weeds and pests (Buckles, 1999); and 4) improve soil-water and nutrient retention capacities (Roder *et al*., 1995): preventing the leaching of nutrients particularly in coarse-textured soils.

To overcome the low fertility of rainfed lowland particularly coarse-textured rice soils and to sustain both rice production and soil health, applying inorganic fertilizer alone is not the best management option, but the effects of different types of organic matter combined with appropriate chemical fertilizer on subsequent grain production have been investigated in South and Southeast Asia (Zhu and Xi, 1990; Alberto *et al*., 1996; Ruaysoongern *et al*., 1996; Whitbread *et al*., 1999), but not much in Cambodia (Pheav, 2002). The study of return of plant residues has received greater attention in recent years in low chemical input agricultural systems of the tropics because organic sources of nutrients are believed to play a major role in restoring the soil health, and in a cropping sequence they may be more effective than inorganic fertilizers if they leave sufficient residual nutrients for the succeeding crop/crops (De Datta, 1989; Songmuang *et al*., 1997). For example, studies in Cambodia by Mak and Nesbitt (1993); Seng *et al*., (1999), and Pheav (2002), showed complementary effects of green manure (S. rostrata) or rice straw with/without inorganic fertilizers by increasing rice yields on sandy soils of Cambodia even under temporarily loss of soil-water saturation. The preliminary results of a pot experiment by Pheav (2002) indicated that incorporation of early wet season fallow crops increased growth and P uptake of rice, and also improved soil P reserves (organic P pool), and microbial biomass C, N, and P that could be an important source of nutrients available for succeeding rice crop/crops.

For the rainfed lowlands of Cambodia, there remains a need to understand further for the double cropping option, the short- and long-term effects of nutrients

recycled from rice, and dry- and early wet season crops or fallow residues, and its effects on the sustainability of nutrients in the rainfed lowland rice crops.

1.1 Rationale

Poor rice yield has a major impact on national agricultural production, resulting in food shortages. Low agricultural productivity particularly in rice is a result of both natural abiotic and biotic factors, and socio-economic constraints (Chea *et al*., 2001). Poor yields in Cambodian rice production were attributed to constraints such as erratic rainfall, poor soil fertility, pests and diseases, traditional varieties, small farm size, and inadequate labour, farm power or capital. These constraints combine to cause rice yield in Cambodia to be the lowest amongst Asian rice-producing countries (Javier, 1997).

Soil fertility is one of the most serious constraints to rice yield improvement (White *et al*., 1997b). Cambodian rice soils are generally infertile, probably as a result of continuous cultivation without adequate replenishment of nutrient losses by plant uptake in addition to the effects of runoff, erosion and leaching (Javier, 1997), coupled probably with factors such as ferrolysis (accelerated weathering of clay) due to intermittent wetting and drying cycles, and the destruction of clay mineralogy by acidification (Brinkmann, 1970). Most soils are deficient in N and P, and some may be K, S and Mg-deficient according to results of both the pot and field experiments (Lor *et al*., 1996; Pheav *et al*, 1996). Other macro-and micro-nutrients disorders are evident when the main fertilizers N, P, K, S and Mg are applied. In addition, a number of problem soils exhibit iron (Fe) toxicity, acidity, and/or high salt concentrations in some areas (White *et al*., 1997a; Seng *et al*., 2001). The high fields have the highest sand content, and therefore the poorest water- and nutrient-holding capacities. The low fields are the most fertile soil, but some soils are still poor in terms of N and P contents regardless of the field level (White *et al*., 1997a,b).

The cultivation of one crop of traditional rice varieties in the wet season is the commonest form (Javier, 1997) in rice farming system of Cambodia, and this system normally has very low productivity. Lando and Mak (1994a) indicated that although

traditional varieties have low yields, farmers remain satisfied with them because of their good grain qualities or adaptability to a range of abiotic stresses. Rice yields less than 1.0 t/ha, are common particularly on very acid soils without fertiliser application (White *et al*., 1997a,b).

In this context of poor soil fertility and rice productivity, study of fertility management including crop residues is important to increase the rice productivity particularly in rainfed low land areas.

1.2 Objectives

The objectives of the study are:

1. To assess the effects of applied chemical fertilizers and rice straw on crops yield of rice-based cropping systems
2. To investigate the effect of crop residue on productivity of rice-based cropping systems.