Yield Trends and Soil Mineral Changes in Three Summer Winter Forage Cropping Systems for 5 Consecutive Years in Southern Kyushu, Japan

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Yield trends and soil mineral changes in three summer winter forage cropping systems for 5 consecutive years in southern Kyushu , Japan

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Key words : cropping system , forage crops , mineral balance , yield

Introduction Mineral balance between plants and soil to which fertilizer is applied is important in a sustainable agriculture (Haynes and Naidu , 1998) , especially on unfavorable soil conditions . Cropping systems are chosen based on considerations of crop yield , soil physical and chemical properties and climatic conditions . Summer crops of maize (*Zea mays* L . : M) and sorghum (*Sorghum bicolor* Moench : S) and a winter crop of Italian ryegrass (*Lolium multiflorum* Lam . : IR) are major forage crops in southern Kyushu of Japan . This study tested three cropping systems typical to the region (double cropping of M and IR (M-IR) , double cropping of S and IR (S-IR) , and double cropping of maize (M-M) for 5 consecutive years for their performance in yield and mineral balance on the non-fertile , poorly permeable heavy soil .

Materials and methods Field experiments were conducted based on the standard regional cultivation under the heavy soil and three different summer-winter forage cropping systems were examined for 5 years (May 2001-April 2006) . Samples of all plants , divided into each plant organ , were oven-dried to determine dry matter yield . Total nitrogen (TN) of plant and soil was analyzed by Indophenol method . The TN balance was calculated as input in fertilizer minus output in harvested crop .

Results and discussion Annual dry matter yield of three cropping systems on the heavy soil is shown in Table 1 . The annual variation of herbage yields of summer crops (52 .8% and 54 .4% in M and S , respectively) was greater than that of winter crop , IR (23 .1%) . Low yields of summer crops were associated with frequent typhoons and heavy rainfalls . Consequently , in M-IR and S-IR , incorporation of IR into the cropping system decreased the year-to-year variability in herbage yield (31 .2 and 48 .3% , respectively) . In TN balance , the input in fertilizer was larger than the outputs in herbage for all cropping systems (Figure 1) . Thus , TN content of soil increased in the fifth year , except for M-M . The TN balance of summer crops (M and S) decreased from the first year to the fifth year due to the increase in yield and TN content of crops .

Table 1 *Annual dry matter yield (kg/m^2) of 3 cropping systems on the heavy soil .*

Year	M—IR	S—IR	M—M
2001—2002	2 .13	2 .06	1 .90
2002—2003	1 .56	—	2 .43*
2003—2004	1 .60	1 .81	1 .50
2004—2005	0 .90	—	0 .77
2005—2006	2 .49	2 .12	1 .36
Mean	1 .74	1 .56	(1 .59)**
SD	0 .54	0 .76	(0 .55)**
CV (%)***	31 .2	48 .3	(34 .8)**

* M-IR , ** Excluding data in 2002-2003 , *** Coefficient of variation .

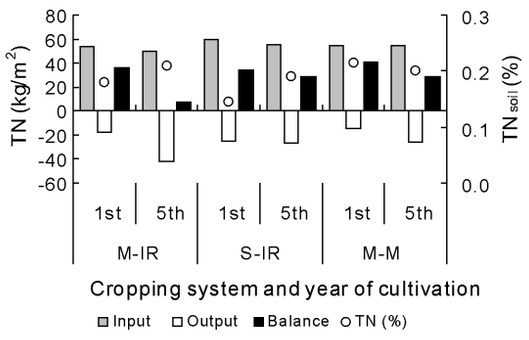

Figure 1 *TN balance and TN contents of soil (TN_{soil}) in 3 cropping systems on the heavy soil .*

Conclusions The results confirm the relatively low productivity on the heavy soil and show the advantage of combining a winter crop with a summer crop for stabilizing annual herbage production on the heavy soil in southern Kyushu . Even in the heavy soil , consecutive cropping might contribute to increase the soil fertility and yield of summer crops , and to reduce the mineral balance remained in the soil environment .

Reference

Haynes , R J . , Naidu R . , 1998 . Influence of lime , fertilizer and manure applications on soil organic matter content and soil physical conditions : a review . *Nutrient Cycling in Agroecosystems* 51 , 123-137 .