Soil carbon distribution and soil physical properties as affected by rice-barley long-term double cropping system in Korean paddy fields

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Abstract
Cropping system and organic matter affect crop productivity and soil chemical-physical properties. This study was carried out to evaluate the effects of a double cropping system in paddy fields in Korea. Rice mono cropping systems, rice-barley double cropping system with and without barley straw were evaluated from 1990 to 2009. Soil organic carbon and physical properties such as bulk density, cone index, aggregate distribution at different soil depths were investigated.

The amount of total soil organic carbon of up to a depth of 30 cm in a rice-barley double cropping system was higher than for a rice mono cropping system. The amount of total soil organic carbon in the upper 12-cm depth of soil from the fields with removal and recovery of barley straw did not significantly differ. Bulk density and cone index were found to decrease under the rice-barley double cropping system. On the other hand, the bulk density of the upper 30-cm depth of soil from fields with recovery of barley straw was significantly different from the other treatments.

The rice-barley double cropping system was more effective than the rice mono cropping system in increasing soil organic carbon for the improvement of soil fertility and physical properties in paddy fields of Korea. Furthermore, barley straw recovery in the rice-barley double cropping system with rice straw recovery was not effective in increasing soil organic carbon and improving physical properties.

Key Words
Rice, Barley, Double cropping, Soil carbon, Physical properties

Introduction
The level of agricultural productivity in Korea, a small country, has been increased by the double cropping system. Most rice and barley straw is utilized as feed for livestock by recovering straw from the fields. Double cropping rice-barley is an effective cultivation technique for improving soil chemical, physical properties and productivity compared to the mono cropping system. Improving soil organic carbon and physical properties with different cropping systems involving retention of organic materials is important in maintaining productivity and reducing global warming increasing by carbon sequestration in the long term in paddy fields.

Materials and Methods
1) Treatments (1990~2009)
- Mono culture : Rice mono cropping
- Rice-Barley (Removal): Rice-barley double cropping system without barley straw
- Rice-Barley (Recovery): Rice-barley double cropping system with barley straw

2) Fertilizer and organic matter schemes

Cropping system	1990~1998 (kg ha^{-1})			1999~2009 (kg ha^{-1})			Barley Straw (Mg ha^{-1})
	N	P_2O5	K_2O	N	P_2O5	K_2O	
Rice mono cropping	90	70	80	90	45	57	
Rice-Barley (Straw removal)	90	70	80	90	45	57	
Rice-Barley(Straw recovery)	90	70	80	90	45	57	45

3) Rice straw recovery in all treatment
4) Soil Properties
. Soil series: Pyeongtaeg *(mixed mesic, Typic Haplaquepts)*
. *Fine silty loam (somewhat poorly drained fine silty)*

Results

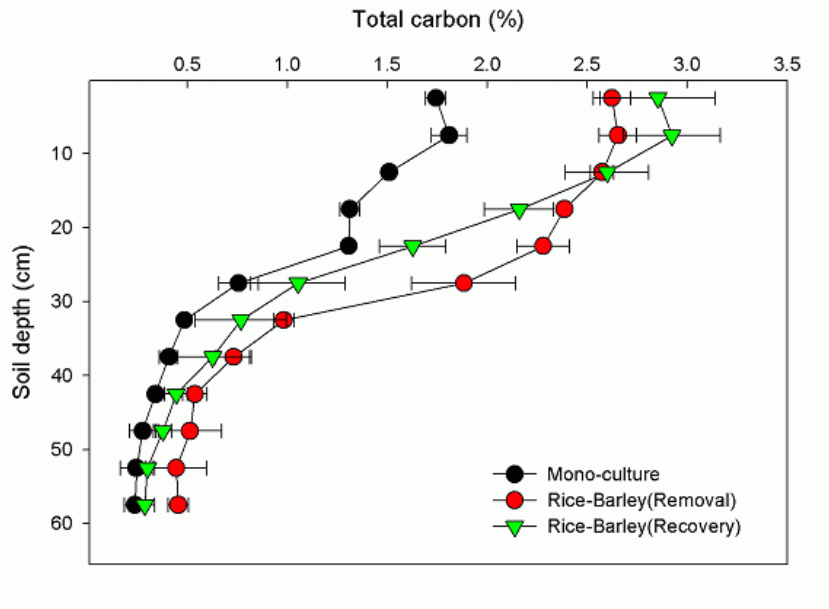


Figure 1. Changes in soil organic carbon concentration with soil depth under different cropping systems for a long term rice paddy field.

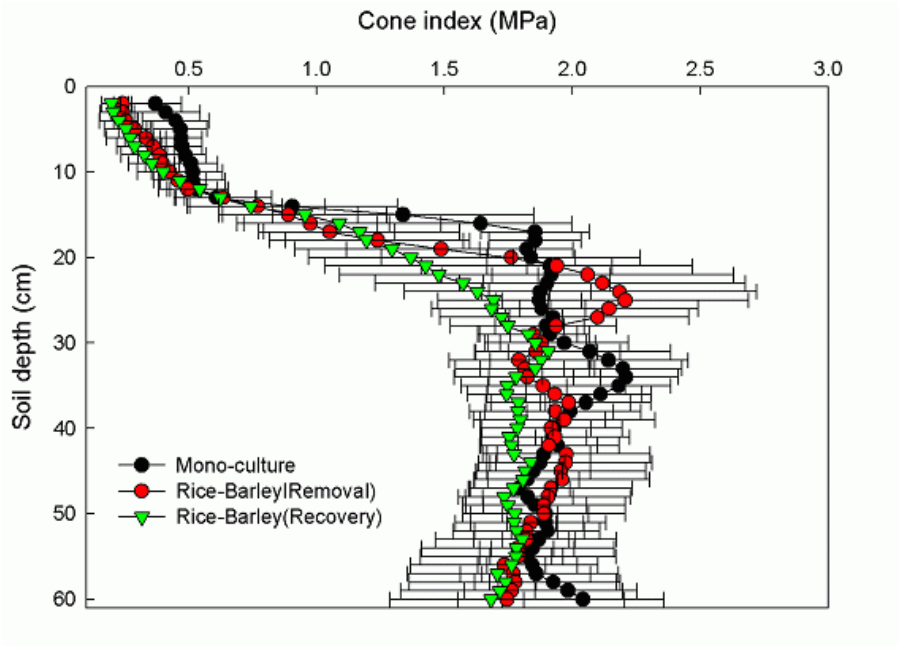


Figure 2. Changes in cone index with soil depth under different cropping systems in a long term rice paddy field.

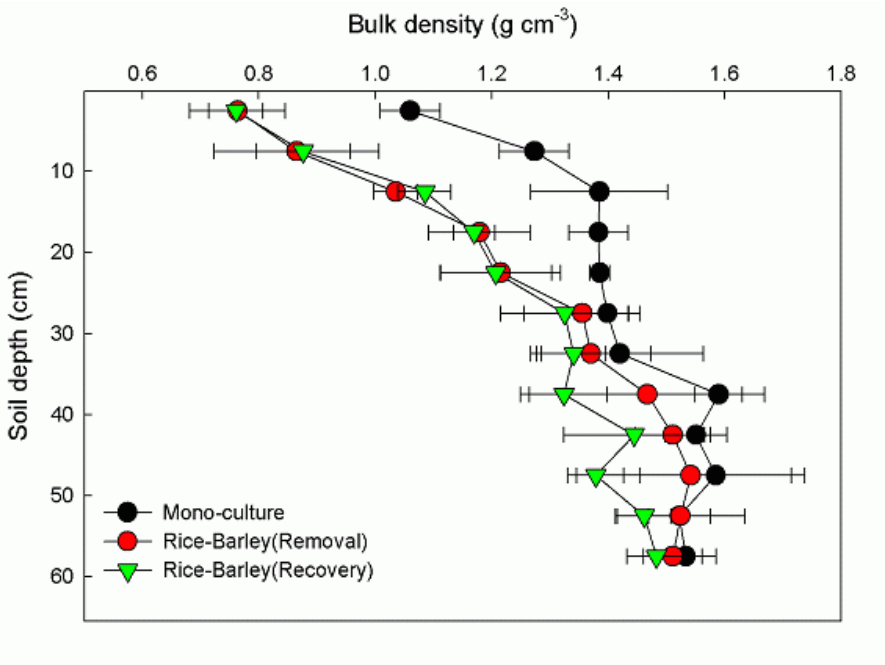
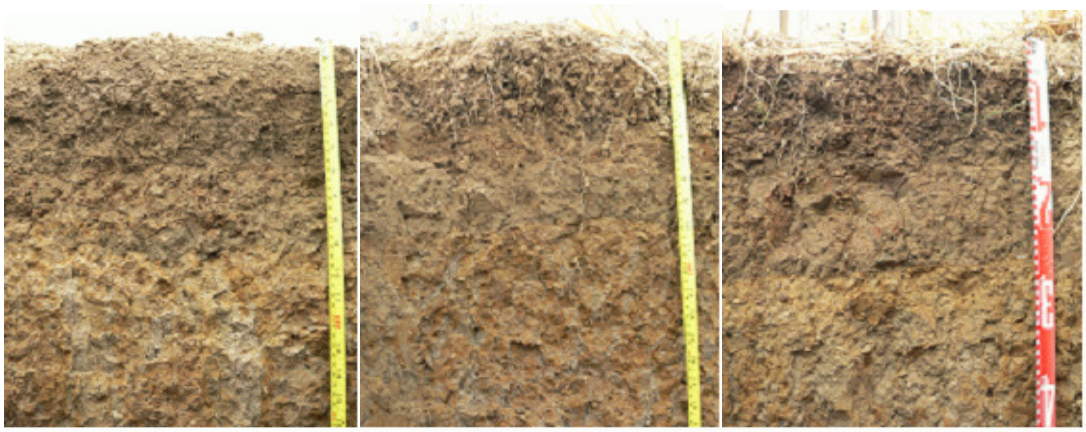


Figure 3. Changes in bulk density with soil depth under different cropping systems in a long term rice paddy field.



<Rice mono culture> <Rice-barley (Removal)> <Rice-barley (Recovery)>

Figure 4. Soil profiles for different cropping systems in a long term rice paddy field.

Conclusion

The rice-barley double cropping system is an important cultivation method for organic matter application in paddy fields. Continuous rice-barley cultivation increases the soil carbon concentration in the upper 30-cm soil layer with a corresponding decrease in bulk density. The rice-barley cropping system could be a good management practice to substantially improve yield by increasing carbon storage in the soil profile. Soil organic carbon and soil physical properties under the rice-barley double cropping system with recovery of rice straw did not significantly differ from that of fields without recovery of barley straw. Further work is needed to evaluate the maintenance of productivity and the best management practice for soil fertility under a double cropping system in long term paddy fields.

References

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