Soil compaction: Old but a new problem in Fukushima caused by decontamination.

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Soil compaction has been a serious problem in agricultural lands. Batey (2009) reviewed reasons of soil compaction at agricultural lands. Jones et al. (2003) reported fine and very fine textured soils are less, i.e. low to moderate risk, susceptibility to compaction, while coarse and medium textured soils especially those are under lightly packed condition have high risk to compaction. Stress caused by traffic of agricultural machinery is a typical cause of soil compaction. The stress makes dense layer at a depth of arable land. Rise of dry bulk density may cause decrease in hydraulic conductivity, and increase in soil hardness. Then, increase in runoff during rainfall event, water logging during and after the precipitation as well as depression of germination of seeds occurs.Later, Chamen et al. (2015) discussed cost for mitigation of arable soil compaction.
In Fukushima, 20000 ha of agricultural lands have been decontaminated after the accident of Fukushima Dai-Ichi nuclear power station on March 2011. In this process, skimming the surface 5 cm thick soil layer was employed for agricultural lands which had radioactive materials in surface soil greater than 5000 Bq/kg-soil. Area of surface soil stripping was approximately 8300 ha in Fukushima prefecture. Stripping surface soil was conducted by using backhoes or a turf stripper and a skimmer attachment for tractors. After the skimming clean, radioactive material free, subsoil was dressed and leveled. The leveling was the end of decontamination procedure. During the decontamination activity, traffics of machinery could have caused soil compaction. The soil compaction may be an obstacle for farming resume after the power plant accident. Thus, in this study, extent of soil compaction at decontaminated paddy fields in Iitate village in Fukushima was surveyed for near future resume of agricultural activity.
In the field, cone penetrometer test and infiltration test using disk permeameter were conducted. Besides, disturbed and undisturbed soil samples were taken and brought back to the laboratory for soil physical analysis such as saturated hydraulic conductivity, dry bulk density, porosity, and texture of the soil. Texture of the original soil was mostly heavy clay, and dressed soil had light clay texture. Paddy fields typically have a dense layer that we called hard pan at a depth of 20cm to 30cm. Hardpan has a role to keep ponding water depth. Specific feature of each hardpan is variable depending on soil physical property and history of agricultural practices. Cone penetrometer test at a paddy field in Iitate suggested in addition to the common hardpan an alternative one occurred at shallower layer, 5 to 15 cm in depth. This shallow hardpan was suspected to form due to load of traffic of heavy machinery during decontamination. The additional hardpan was observed at 4 sites out of 8 survey points in the paddy field. Saturated hydraulic conductivity of undisturbed sample from shallow layer, 5 to 30 cm in depth, was 2.0 mm/h. That of the deeper layer, 30 cm to 80 cm in depth, was slightly greater than the shallower layer, 2.3 to 4.5 mm/h. Since texture of the soil was rather fine hydraulic conductivity tended to be low. In situ infiltration test by using tension disk permeameter gave similar results for the shallow layer. Low saturated hydraulic conductivity of shallow layer could be due to compaction by decontamination machinery. As far as using the field as paddy rice cropping this would not a problem, however, if a farmer prefers to use the same field for pasture, vegetable or cereals or other cash crops other than paddy rice, low hydraulic conductivity of surface soil due to compaction would be a problem to be mitigated.
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