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# 学位論文審査の結果の要旨
Summary of Doctoral Dissertation Examination

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| 題　　目<br>Title | Role of soil microbes from remnant Church Forest to assist seedling establishment of native tree species in a degraded land |

審査結果の要旨（２,０００字以内）／Summary of Doctoral Dissertation Examination (Within 1200 words)

In Ethiopia, due to its prolonged and unsustainable agricultural history, land degradation has been causing the most severe problem on agricultural production as well as other ecosystem services. On the other hand, there have been efforts made by different development actors on its countermeasures that include afforestation, and establishment of exclosures (protecting from human and animal interference). The significance of such efforts (*i.e.*, exclosures) in improving soil fertilities and vegetation cover is relatively better studied. However, achieving restored ecosystem function and diversity through the establishment of native tree species has proved a challenging task due to the slow nature of the process and poor availability of beneficial soil microbes in the degraded lands. Whereas small patches of natural forest called “Church Forests”, which constitute the last remnants of the original forest cover in Ethiopia, have been conserved for centuries. These Church Forests, on top of their social and spiritual values, they are foci of biodiversity being used for seed sources and germplasm conservation sites for native fauna and flora.

Thus, his research aimed to contribute for the assisted-restoration of native trees in severely degraded lands through using Church Forest soils as a source of native microbes by integrating field survey, laboratory and field experimentations. To address this aim, he conducted the following specific studies: (1) prioritize severely degraded areas for management intervention through assessing soil organic carbon (SOC) and total nitrogen (TN) stocks in different land uses and topographic positions found in three agro-ecosystems of the Upper Blue Nile basin, (2) clarify the soil microbial potential of Church Forest soil and its effect on seedling growth of selected native trees species under glasshouse conditions and (3) evaluate the role of Church Forest soil in assisting the seedling establishment of a selected native tree under a degraded land field conditions.

The main results corresponding to the three specific studies are presented in the following subsequent sections being followed by an overall conclusion of the study.

Firstly, through analyzing SOC and TN based on 352 soil samples taken from 4–land uses, 3–topographic positions and 3–soil depths in Guder (highland), Aba Gerima (midland) and Dibatie (lowland) watersheds, he prioritized severely degraded areas for management intervention. He found that land use, topographic positions, agro-ecosystems and their interactions have a significant influence in both stocks. Not surprisingly, the cropland located in the upper topographic position was found the most degraded land use type, highly attributed to higher erosion rate. However, unlike the normal assumption, plantations exhibited lower SOC and TN stocks due to poor undergrowth and overexploitation for charcoal and firewood production including the roots. Specifically, among the three watersheds, Aba Gerima was found under a severely degraded situation owing to prolonged cultivation and unsustainable human activities, thus revealing the need for immediate land management interventions.

Secondly, through using soils from Church Forest in Aba Gerima watershed under glasshouse conditions conducted in Tottori, he clarified the microbial potential and its effect on seedling establishment of *Olea europaea* and *Albizia gummifera* native tree species. Higher plant height, root collar diameter, shoot and total biomass were observed for seedlings grown in non-sterilized (with microbes) forest soils than those grown in sterilized (without microbes) soil. Furthermore, the relative abundance of *Acidobacteria*, *Actinobacteria*, and *Nitrospirae* was significantly correlated with non-sterilized forest soil bacterial community ($r^2$ = 0.6–0.8, $p < 0.001$). He attributed the favorable soil pH environment of the forest soils to strongly affect the abundance of the bacterial community in the Church Forest soils. This effect was more noticeable on the performance of Olea seedlings grown in the soil from *Croton macrostachyus*. This suggests that soil from remnant Church Forests, particularly soil from beneath *Croton macrostachyus*, can serve as a good inoculum source for native tree seedling survival and growth in degraded lands.

Thirdly, through field experimentation established in July 2018 under a degraded land condition in Aba Gerima watershed, he evaluated the role of Church Forest soil in assisting seedlings of *Olea europaea* establishment. Olea seedlings assisted with soil from Church Forest exhibited higher survival and growth than seedlings without Church Forest soil. Assisted and non-assisted seedlings had survival rates of 89% and 77%, respectively. Significantly higher mortality of non-assisted seedlings was observed particularly during the months of 3–6 starting from the planting date implying the immediate effect of soil microbes. Similarly, the height of assisted seedlings was higher with a mean value of 85.7 (±5.3) cm compared to 74.5 (±2.3) cm in non-assisted ones. The results of this study confirm that Church Forest soils can assist seedlings establishment of native tree species in degraded lands.

In conclusion, through integrated field survey, laboratory and field studies, the candidate clarified that Church Forest soils are endowed with beneficial native microbes (mainly bacteria and fungi), which can serve as a source for native soil inoculum. Use of this inoculum source can facilitate native trees seedlings establishment, growth and survival in restoration of degraded lands. His study has both high scientific and developmental significance to support the effort in restoration of degraded lands using soils from Church forest as inoculum source. On the basis of the above background data, members of the Examining Committee unanimously voted for that the PhD thesis of Mr. Getu Abebe Messalea presents original research results of large importance and recommended for the award of his doctoral degree.