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Quality assessment for brick making of the bleached topsoil of Vertic Planosols in the south-western Ethiopian Highlands

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Planosols are a very common soil type in Ethiopia. The Vertic Planosols of the south-western Highlands are typical examples of duplex soils, characterized by a bleached, silty top horizon abruptly overlying a heavy clay subsoil. The bleached topsoil material is of local economic importance as it is extensively used for brick making. The aim of this research was to assess the quality of locally produced bricks following Ethiopian and European quality standards, and formulating recommendations to improve the quality of the bricks.

After a reconnaissance field survey three brick production sites, Bore, Serbo and Marawaa, were selected. At each site the bleached topsoil was sampled for physico-chemical analyses and locally produced bricks were collected for further testing. The production process, documented by interviewing locals, consists of excavating the bleached topsoil, manual mixing with water, shaping using an ash-covered wooden mould, trimming using an iron wire, and drying in open air. About 30,000 dried bricks are then piled up to form a rectangular field-oven and fired for about two and a half days. It was observed and admitted by the locals that about 10% of the produced bricks are lost due to severe cracking and/or melting on the inside of the field oven. On the other hand, some of the bricks on the outside of the field oven were not sufficiently fired.

Physico-chemical (texture, total elemental chemical composition, carbonate content, total carbon content, sulphur content, cation exchange capacity, total specific surface) and mineralogical (XRD, DSC, thermogravimetry, dilatometry, optical microscopy) analyses were carried out. Additionally, the locally produced bricks were physically characterised by their dimensions, initial rate of water absorption (IRWA), water absorption after 24h and compressive strength. Based on the observed properties for the soil material and the locally produced bricks, mixtures of soil samples and a sand additive were made in an attempt to improve the quality of the bricks. In addition, the effect of the moulding method was taken into account by making both hand-moulded and pressure-moulded bricks from both the reference soil material and the improved mixture. These new bricks were also tested on water absorption, drying, firing and total shrinkage and compressive strength.

The analytical results indicated the locally produced bricks are quite strong, but absorb too much water when matched with European and Ethiopian standards. New bricks made from the improved mixtures show a significantly lower water absorption. Compressive strength on the other hand, is slightly reduced for these test units, but still above standard levels. A lower variability in measured values when using pressure-moulded test units compared to hand-moulded test units indicated the former result in a more uniform quality of bricks. It can be concluded that the current locally applied methods and materials produce a moderate quality brick on average, with large variation in the quality. Use of a sandy additive, adjusting the moulding method and improving the field oven layout to achieve a more homogeneous temperature distribution, are surely options to improve the quality of the bricks produced from these bleached materials.