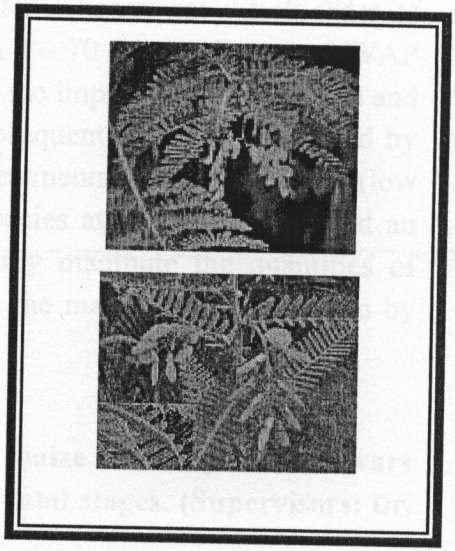
1.1.5 Chirwa Teddy S. (2000). Changes in soil properties and their effects on maize (*Zea mays* L.) productivity following sesbania (*Sesbania sesban* (L.) Merr.) and pigeon pea (*Cajanus cajan* (L.) Millsp.) improved fallow systems in Eastern Zambia. (Supervisors: Dr. D. M. N. Mbewe, Dr. P. L. Mafongoya and Dr. B. H. Chishala).

Soil degradation is a major constraint to sustainable food production in most sub-Saharan African countries. Short fallow rotations of 1 – 3 years have a potential to increase maize yield without additional inorganic nitrogen fertilizers. The mechanisms responsible for improved maize yield are partially understood. Therefore, the objectives of the study were (1) to quantify some changes in soil properties that may be responsible for improvement in crop productivity under fallow cultivation systems compared with continuously cropped maize system, and (2) to quantify the nitrogen mineralization patterns when mixing litter (dry leaves or senesced leaves) and fresh leaves of fallow species. The study was laid out as a Randomized Complete Block Design with three replications on a sandy loam (Typic kandiustalf) in eastern Zambia. The treatments compared wre two year old planted improved fallow of *Sesbania sesban* (L.) Merr and *Cajanus cajan* (L.) Millsp; respectively, natural vegetation (Nf), continuous fertilized (M+f) and unfertilized maize (M-f) monoculture. The following parameters were measured; growth (performance) of trees, N mineralization patterns, soil mineralizable inorganic nitrogen, dry matter (DM) accumulation, maize yields, soil bulk density, soil porosity, soil organic carbon, soil penetration resistance, water aggregate stability and distribution, infiltration rate and soil water content. The highest survival rates were recorded in sesbania (92%), whle pigeon pea had only 31%. At the end of the 10-week incubation period, the N mineralization of sesbania (fresh leaves



+ litter) reached 59.4 mg Nkg^{-1} soil as compared to 5.1 mg Nkg^{-1} soil for pigeon pea litter. Natural fallow had a cumulative net immobilization of 0.8 mg Nkg^{-1} soil. M+f had the highest pre-season soil inorganic nitrate-N and total inorganic N in 0 – 20 cm soil depths but were not significantly different with pigeon pea and sesbania land use systems (LUSs). A polynomial regression model between maize grain yield and pre-season soil inorganic nitrate-N for 0 – 20 cm, 0 – 40 cm and 0 – 60 cm soil layers showed that the amount of pre-season inorganic nitrate-N in the soil layer accounted for 70%, 67% and 69%, respectively, of the maize yield. As was the case with pre-season soil nitrate-N, total inorganic N in 0 – 20 cm, 0 – 40 cm and 0 – 60 cm soil depths were significantly correlated with grain yield (R^2 = 0.70, 0.66 and 0.70, respectively). The maximum N accumulation in maize above ground biomass at 24 WAP averaged 156.9 kg N ha^{-1} and 77.0 kg N ha^{-1} for M+f and the sesbania, respectively, with grain yields of 5.51 and 3.02 tha^{-1}, correspondingly. The highest total biomass was recorded on the M+f (9.52 tha^{-1}), followed by sesbania (6.02 tha^{-1}), but was not significantly different at $P \leq 0.05$. Penetrometer resistance measured at 4 WAP at 5 cm soil depth ranged from 0.65 MPa to 1.15 MPa for pigeon pea and M-f land use systems, respectively. The highest wet mean weight diameter (WMWD) was recorded in the pigeon pea LUS at both fallow clearing and crop harvest. The percentage of water stable aggregates (>2.00 mm) at fallow clearing was highest (83%) in sesbania and lowest (61%) in M-f LUS. On the other hand at crop harvest, the percentage of aggregates (>2.00 mm) was highest (77%) in pigeon pea and lowest (44%) in M-f LUS. At fallow clearing, the equilibrium infiltration rate was highest (31.8 cm hr^{-1}) in natural vegetation and lowest (12.6 cm hr^{-1}) in M-f LUS. On the other hand at crop harvest the equilibrium infiltration rate was highest (23.4 cm hr^{-1}) in sesbania and lowest (10.2 cm hr^{-1}) in M-f. Similarly, cumulative water intake after 3 hours at fallow clearing was in the order of Nf = pigeon pea ≥ sesbania > M+f ≥ M-f. on the other hand at crop harvest, the cumulative water intake after 3 hours was int eh order of sesbania > Nf = pigeon pea = M+f = M-f. Soil water storage in 0 – 70 cm soil layer at 8 WAP was highest (236 mm) in sesbania and lowest (209 mm) in M+f. the improved soil condition and nitrogen contribution of sesbania and pigeon pea fallows to subsequent crop was evidenced by increased maize yield after fallow as compared to no tree treatments. Mixing of litter (low quality) with fresh leaves (high quality) from the same tree species at fallow clearing had an effect on maize N uptake. Therefore, there is need to carefully manipute the quantities of material (fresh leaves and litter) at fallow clearing so as to get the maximum N utilization by maize plants in improved planted fallow systems.