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MODELLING THE SURVIVAL OF AN ESCHERICHIA COLI IN SOIL

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Introduction

Since beginning of civilization, animal waste has been used as fertilizers. It is estimated that on an average, about 80% of nitrogen and phosphorus and 90% of potassium and 50% of organic matter of the food consumed by farm animals is recovered in the manure (Van Slyke, 1993). High acidity of West Sarawak soils results in undesirable effects such as nutrient deficiency (Andriesse, 1972). Therefore, integration of plantation crops with livestock could be a solution to this deficiency. It could reduce cost involved in chemical fertilizers and also reduce disposal problems of animal waste. However, there are water quality concerns in livestock farming areas such as contamination of water by pathogens from animal waste (Hooda et al., 2000). Therefore, proper waste management is needed to minimize the negative impact of integrated farming. Modelling the survival of an indicator bacterium, E. coli can assist in the management of waste by determining optimum timing of waste application or loading. In order for models to give accurate prediction of *E. coli* population in the soil, initial regrowth and also die-off rates as a function of environmental conditions need to be developed.

E. coli is found in large numbers in the intestinal tract of warm blooded animals. Key environmental factors affecting the survival of E. coli in the soil includes temperature and moisture (Reddy et al., 1981; Crane and Moore, 1986). Lower temperatures and higher soil moisture were found to increase bacterial survival time (Klein and Casida, 1967; Sjogren, 1994; Howell et al., 1996; Cools et al., 2001). Ling et al. (2003) studied the effect of temperature and moisture in a clay loam in Sarawak reported that both temperature and moisture affected decay rate of E. coli and interaction of temperature and moisture was significant. However, survival in soil temperature below 25°C and beyond two weeks was not investigated. Cools et al. (2001) investigated survival of E. coli between 5-25°C, which is only applicable in temperate regions. Initial regrowth of E. coli in soil was reported by Byappanahalli and Fujioka (1998) and Howell et al. (1996). However, the rate of regrowth as a function of environmental conditions is not available in literature.

Linear first order die-off model is the most common model used to predict bacterial die-off (Crane and Moore, 1986; Matthess et al., 1988). It may be expressed as

$$N_t / N_0 = e^{-kt} \qquad [1]$$

where: N_t is the number of bacteria at time t, N_o is the number of bacteria at time 0, t is the time (d), and k is the first order or die-off rate constant (d^{-1}).

According to Reddy et al. (1981), temperature is one of the key factors controlling the death rate of E. coli and the effect of temperature on the death rate can be modeled by adjusting the decay rate coefficient according to

$$k_2 = k_1 \theta^{\Delta T} \qquad [2]$$

where: ΔT is the difference in temperature, i.e. T_2-T_1, k_2 and k_1 are the decay rates at temperature T_2 and T_1 respectively, and θ is the temperature correction coefficient.

For the range of 5-25 °C, temperature correction coefficient for the decay of E. coli was reported but it was based on E. coli die-off in river water and not soil. Ling et al. (2003) reported temperature correction coefficient but not those below 25°C. In this study, both