The Impact of Different Grassland Land-Uses on Earthworm Populations in a New Zealand Fragi-Pallic Soil

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Introduction In the North Otago region of New Zealand's South Island , the first stage of a new irrigation scheme has recently been completed allowing land use to change from dryland sheep farming (10 stock units/ha) to more intensive irrigated dairy farming (>20 s .u ./ha) . The implications for the pasture and soil resources of this region (pallic soils characterised by weak structure and a compact fragipan subsoil horizon) are largely unknown . Reported here are the impacts of different land-use treatments on earthworm populations .

Methods Factorial combinations of harvest method (cattle grazing , sheep grazing , mowing and pasture fallow) , pasture species [perennial ryegrass (R) and tall fescue (F)] and irrigation (with and without) treatments were applied to 24 paddock pairs . Enough nitrogen (N) was applied (in split applications) to one paddock of each pair so that N was not limiting pasture growth (see White & Knight 2007 for details) . In winter 2006 and 2007 , four to eight 10 cm wide×20 cm deep cores were taken from each paddock and all earthworms were found and counted .

Results Irrigation , harvest method , pasture species and nitrogen all affected earthworm numbers (Figure 1) . There were fewer worms under cattle grazing compared to sheep grazing , mowing and fallow in 2006 . In 2007 , there were fewer worms under cattle grazing and mowing than fallow which had less worms than sheep grazing ($P<0.001$) . Overall , there were 80 and 73% more earthworms in irrigated soil compared to dryland soil in 2006 and 2007 , respectively ($P<0.001$) . However , the increase in worms due to irrigation in 2006 was greater under sheep grazing and fallow than cattle grazing and mowing ($P<0.01$) . There were more earthworms in ryegrass compared to fescue paddocks but only when combined with fallow (2006 and 2007) and sheep grazing (2007 only) ($P<0.03$) . Adding N had no effect on worm numbers in 2006 . In 2007 , there were fewer worms overall in plus-N paddocks but this effect was only significant when combined with irrigation and cattle grazing or mowing ($P<0.05$) .

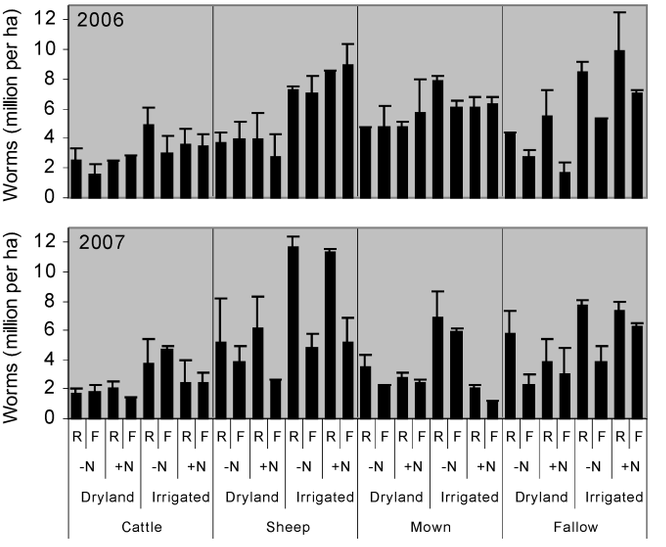

Figure 1 *Total earthworm number (million per ha) under different land-use treatments over two winters .*

Conclusions Irrigation increases whereas cattle grazing generally decreases worm abundance . The greater number of earthworms in irrigated soil agrees with previous research and relates to their need for a moist well-aerated environment (Lee 1985) . Pasture grazing/harvesting impacts on earthworm populations have received little research attention . Fewer earthworms under cattle grazing may be related to greater soil bulk density , lower macroporosity and injury from trampling (Bruyn & Kingston 1997) . Future research will examine worm biomass and earthworm species abundance to help understand how land use change may affect the potential beneficial processes performed by earthworms in soil .

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