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Agricultural production systems that include complimentary plant, soil and animal interaction contribute to sustainability. In sustainable livestock systems integrated with crop production, the soil resource is impacted positively. The goal of this research was to maximize beef cattle and crop economic yield, while improving the soil resource by increasing soil organic matter (SOM) and subsequently seasonal soil nitrogen fertility over a 5-year period (2011-2015). Each experimental crop field used in the study was 1.74 ha. Small-seeded crops were planted using a JD 1590 No-Till drill. Corn (C) and sunflowers (SF) were planted using a JD 7000 No-Till planter. The cropping sequence used in the study was SF, hard red spring wheat (HRSW), fall seeded winter triticale-hairy vetch (T-HV), spring harvested for hay/mid-June seeded 7-species cover crop (CC; SF, Everleaf Oat, Flex Winter Pea, HV, Winfred Forage Rape, Ethiopian Cabbage, Hunter Leaf Turnip), C (85-day var.), and field pea-barley intercrop (PBY). The HRSW and SF were harvested as cash crops and the PBY, C, and CC were harvested by grazing cattle. In the system, yearling beef steers grazed PBY and unharvested C before feedlot entry, and after weaning, gestating cows grazed CC. Seasonal soil nitrogen fertility was measured at 0-15, 15-30, and 30-61 cm depths approximately every two weeks from June to October, 2014.

The regression illustrating the relationship between SOM and average seasonal available mineral nitrogen shows that for each percentage increase in SOM there is a corresponding N increase of 1.47 kg/ha. Nitrogen fertilizer applications for the 5-year period of the study were variable; however, the overall trend was for reduced fertilizer requirement as SOM increased. At the same time, grain, oilseed, and annual forage crop yields increased year over year (2011-2015) except for the 2014 crop year, when above average precipitation delayed seeding and early frost killed the C and SF crops prematurely. Crop yields were as follows for the 5 crop years in the study (2011-2015): (1) CC was 0.25, 10.5, 8.03, 1.53, and 7.22t/ha, (2) C silage was 4.08, 9.04, 9.91, 8.65, and 14.4 t/ha, (3) C grain was 1.04, 3.81, 6.09, 3.11, and 5.1 t/ha, (4) SF was 1.10, 1.96, 2.42, 1.31, and 2.29 t/ha, (5) PBY forage was 0.0, 7.68, 11.2, 9.3, and 8.72 t/ha. When cattle grazed annual forage crops (C, PBY, and CC), animal manure and trampling contributed to the overall improvement of soil fertility. These data suggest that the combined effect of a multi-crop rotation that includes animal grazing enhances soil fertility and subsequently crop yields, and animal production for a sustainable integrated agricultural system.