AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2018 – 2020

TITLE: Milk and Forage Production from Mixed or Spatially Separated Simple and Diverse Pastures

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EXECUTIVE SUMMARY:
Diverse pastures containing multiple species help extend the grazing season and reduce the reliance on one or two species to meet all the nutritional requirements of livestock. Planting pasture species in spatially separated adjacent strips can potentially increase the dry matter intake of high quality forages leading to superior animal production. Thus, in the current study, combinations of simple and diverse pasture mixtures in mixed and spatially separated pasture strips were evaluated for their effects on feed intake, milk yield, N partitioning and methane emission of dairy cows. A 7.2-ha paddock was divided into three 2.4-ha blocks to serve as replicates for the experiment. For the purpose, 36 mid-lactation Jersey were used in a randomized complete block design with 9 cows in each pasture (3 blocks each) as follow: 1) simple mixed (perennial ryegrass and white clover); 2) simple spatially separated; 3) diverse mixed (perennial ryegrass, festulolium, white clover, birdsfoot trefoil, and plantain and chicory; 4) diverse spatially separated. Milk yield and quality, N partitioning, and methane emission were measured. Data were analysed by ANOVA based on a 2 × 2 factorial model with significance declared at $P \leq 0.05$. Cows that grazed diverse pastures had greater milk solids and milk protein yields as compared to those that grazed simple pastures. Spatial separation did not affect DMI, milk yield, or milk components except lactose content of milk, which was lower in spatially separated pastures. Although pasture diversity did not affect daily methane production, cows that grazed diverse pastures had lower methane yields per DM eaten as compared to simple pastures. Cows that grazed diverse pastures had lower urine N (%) and urea content and lower daily N output through urine. In conclusion, the diverse pastures containing species with certain

agronomic and nutritional traits such as secondary metabolites can help improving the animal production while decreasing the environmental effect of dairy farming.

OBJECTIVES:

The purpose of this study was to develop sustainable high performing pasture-based dairy production systems where desirable pasture traits for animal performance are maintained at a high abundance in the diet. Specific objectives of the study were to:

1. Assess the effects of pasture species combinations on environment indicators, milk production, and grazing behavior of dairy cows.
2. Determine annual and seasonal production, nutritive value, and botanical composition of forage in simple and diverse pastures in mixed and spatially separated plantings.
3. Quantify the N concentration of milk, blood, feces, and urine of the cows to detect differences in urine on each pasture type.

PROCEDURES:

The study was conducted between 2017 and 2019 at the Oregon State University Dairy Research Farm in Corvallis, Oregon (44° 34' N, 123° 18' W 78 m. a.sl.). A 7.2 ha was used to conduct a 21-day grazing experiment from 3 to 24 April 2019. Dairy cows were offered a dietary treatment of : (**1**) a mixed perennial ryegrass (*Lolium perenne*) + white clover (*Trifolium repens*); (**2**) a spatially segregated perennial ryegrass + white clover; (**3**) a mixed diverse pasture consisting of festulolium (X *Festulolium braunii*), perennial ryegrass, white clover, chicory (*Cichorium intybus*), plantain (*Plantago lanceolata*), and birdsfoot trefoil (*Lotus corniculatus*) or; (**4**) a spatially separated diverse pasture consisting of festulolium, perennial ryegrass, white clover, chicory, plantain, and birdsfoot trefoil. Each group of 3 cows were randomly assigned to one of 12, 0.6-ha pastures where they rotationally grazed within the same pasture at the stocking rate of 5 cows/ha. During the 21-d grazing period, the first 14 d were used to adjust the cows to the assigned dietary treatments (transition period), and the last 7 d were used for experimental measurements. Spatially separated adjacent monocultures in both simple and diverse pastures were grazed commonly, as one pasture at the same time. Cows were strip grazed and allocated an estimated 16 kg of DM/cow per day with a post-grazing residual of 1300 kg of DM/ha. Water troughs were moved as needed to ensure ad libitum access to water. The cows were milked twice daily (approximately 0500 and 1800 h) and offered a new pasture allowance after each afternoon milking. All cows received 2 kg DM of rolled grain mix (corn and barley mix 50:50) and 91 g/d/cow mineral mix offered in two equal portions

immediately after the morning and afternoon milkings throughout the grazing experiment (acclimation and trial periods). The grain mix contained an average of 9% of crude protein (CP), 12.4% of the neutral detergent fiber (NDF), and 2.3% of ash. The mineral mix consisted of calcium: 17-21 %, phosphorus: 7%, magnesium: 8%, sulfur: 1.65%, selenium: 20-24 ppm, and vitamin A: 200 IU/lb. Body condition of cows (BCS) were scored at each sampling day (d 15, 18 and 21) by two trained, independent evaluators using a five-point BCS scale (1 = thin; 5 = fat). Group feed intake was estimated by determining pre- and post-grazing pasture mass with a rising plate meter (PM; Jenquip, Feilding, New Zealand) by collecting 100 measurements in each daily allocation of pasture during the experimental period (last 7 days). Random pluck samples were collected from pre-grazing allocations of each pasture to determine nutritive value and botanical composition of forage on offer. Daily milk yield measurements were automatically recorded by an AfiMilk system (Kibbutz Afikim, Israel). Two milk subsamples were collected from each cow after AM and PM milkings on d 0 (baseline), 15, 18, and 21 to determine milk composition. Immediately after the morning and afternoon milking on d 0 (baseline), 15, 18, and 21, cows were taken into the OSU Dairy free stall barns and restrained for sample collection. Urine samples were collected midstream after manual stimulation of the vulva, acidified below a pH of 3.0 with sulfuric acid to prevent volatilization, and then stored at -20°C until analysis. Feces were collected via manual stimulation or as they defecated and frozen at -20°C until analysis. Blood samples (approximately 20 mL) were collected from the jugular vein. CH4 emission of individual cows was determined using the SF6 tracer method.

SIGNIFICANT ACCOMPLISHMENTS:

The study was completed in December 2019 and a MSc thesis was produced by Lorena Carmona using the data produced in this study. Lorena defended her thesis successfully on January 20, 2020.

BENEFITS & IMPACT:

This work is a new approach in the use of legumes, grasses, and herbs in temperate pastures. It offers new possibilities for the incorporation of plant material with novel nutritional characteristics, but weak agronomic attributes such as slow establishment, poor competition or short life cycle, into livestock grazing systems. The diversity of the pasture maintains milk yield compared to a simple pasture, while it allows an increase in milk solids, through an increase in milk protein, and an environmental and economic benefit from improved control over methane emissions and urea excretion in the diverse pasture system. Spatial arrangement of forage species can increase the pasture quality due to an increase in low competitive plant species (legumes), but this improvement did not affect dairy cow performance.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM:

No

FUTURE FUNDING POSSIBILITIES:
No