Abstract:
A series of studies were conducted to investigate the effect of alternative forages on animal performance and meat quality characteristics of beef cattle. Alternative forages evaluated were legume/cereal wholecrop silage, red clover silage and fescue-based grass silage.

Experiments 1 and 2 examined the effect of offering legume/cereal wholecrop silage with or without grass silage on animal performance, meat quality and fatty acid composition of lean meat from continental cross steers.

In Experiment 1 grass silage (GS) and lupins/triticale (L/T) or vetch/barley (V/B) wholecrop silage were offered either as the sole forage or in combination with GS at a ratio of 70:30, on a dry matter (DM) basis, legume/cereal wholecrop: GS. All silages were offered ad libitum and were supplemented with either 2 or 5 kg concentrates/head/day. Protein intake was stabilised between silage diets through supplementation of soya bean meal to 1239 and 1468 g/day when offered either 2 or 5 kg concentrates/head/day respectively. Lupins/triticale, V/B and GS had concentrations of DM, ammonia nitrogen (N), starch, crude protein (CP) and a pH of, 291, 304 and 251 g/kg fresh, 120, 140 and 90 g/kg total N, 112, 101 and 6 g/kg DM, 97, 147 and 122 g/kg DM and 4.0, 4.7 and 3.9, respectively. There were no significant silage type by concentrate feed level interactions for food intake, animal performance, carcass characteristics, instrumental meat quality or fatty acid (FA) composition of lean meat. Silage type had no effect on silage or total DM intake of animals. Animals offered GS or L/T:GS received a higher (P<0.05) amount of soya bean meal than animals offered V/B or V/B:GS, with animals offered L/T wholecrop silage receiving the highest (P<0.05) amount of soya bean meal. Animals offered solely GS had a higher liveweight gain (P<0.001), carcass weight (P<0.001), carcass gain (P<0.001) and kidney, cod and channel fat (KCC) weight (P<0.05) relative to animals offered L/T, L/T:GS, V/B and V/B:GS. Silage type had no effect on instrumental meat quality. However, lean from the longissimus dorsi (LD) muscle of animals offered L/T wholecrop silage had a higher (P<0.05) concentration of C18:1n9 than animals offered V/B:GS. Animals offered L/T and V/B:GS silage had a higher (P<0.05) omega-6:omega-3 PUFA ratio (n-6:n-3 ratio) than animals offered L/T:GS and GS.

In Experiment 2, five silage diets were offered - solely perennial ryegrass based-grass silage (PGS), fescue/perennial ryegrass based-grass silage (FGS) and lupins/triticale (L/T), lupins/wheat (L/W) and peas/oat (P/O) wholecrop silages offered in combination with PGS on a 5050 dry matter (DM) ratio (legume/cereal wholecrop: PGS). Silages were offered ad libitum once per day and supplemented with either 4 or 7 kg concentrates/head/day. Lupin/triticale, L/W, P/O, FGS and PGS had concentrations of DM, ammonia N, CP and a pH of, 457, 354, 293, 264 and 268 g/kg.
In Experiment 3, PGS, FGS and red clover silage were offered to finishing beef cattle. The PGS, FGS and red clover silage had concentrations of DM, ammonia N, CP and a pH of 353, 196 and 310 g/kg fresh, 76, 133 and 170 g/kg total N, 130, 116 and 165 g/kg DM and 4.10, 4.10 and 4.58 respectively. Perennial ryegrass based-grass silage (PGS), FGS and red clover silage had an in vivo DOMD of 637, 627 and 647 g/kg DM respectively. Silages were offered ad libitum once per day and supplemented with either 1.5 or 4 kg concentrates/head/day. Protein intake was stabilised between silage treatments through supplementation of soya bean meal to 1140 and 1366 g/day when animals were offered either 1.5 or 4 kg concentrates/head/day, respectively. A silage type by concentrate feed level interaction was recorded for dressing proportion (P<0.05) and fat classification (P<0.01). Silage type had no effect on animal performance, *longissimus dorsi* (LD) weight or instrumental meat quality. Meat from animals offered red clover silage and PGS had a lower (P<0.01) n-6:n-3 ratio than animals offered FGS. Animals offered an increased concentrate level recorded a lower (P<0.05) concentration of C18:2n-6.

Experiment 4 measured methane (CH\(_4\)) emissions from Holstein steers offered the PGS, FGS and L/T, L/W and P/O wholecrop silages which were also offered in Experiment 2. The wholecrop silages were offered with PGS on a 50:50 DM ratio (legume/cereal wholecrop silage: PGS). Silage type had no effect on silage DMI, total DMI, CH\(_4\). Silage type had a limited effect on animal performance, carcass characteristics and no CH\(_4\)/DMI or CH\(_4\)/liveweight gain when offered to Holstein steers. When CH\(_4\) emissions (expressed as litres of CH\(_4\)/DMI) from this study were applied to DMI (g/day) values recorded in Experiment 2 for continental steers, continental animals offered FGS had the lowest predicted CH\(_4\) output (litres/day) in comparison to the other silages offered. When methane emissions were expressed as carbon dioxide equivalents (CO\(_2\))/liveweight gain animals offered PGS and L/W:PGS (50:50 DM ratio) had lower levels compared to FGS, and P/O wholecrop silage.

In the final experiment, data from Experiments 1, 2 and 3 were collated and analysed to determine the relationships between animal performance and instrumental meat quality parameters. In addition, carcass pH and temperature data post slaughter collected in Experiment 1 to 3 were included in the data set. Air temperature was also recorded within the chill of all three experiments post slaughter. Higher carcass temperatures (<35°C) were recorded in Experiment 1 and 3 than Experiment 2 and were outside the Meat Standards Australia (MSA) window (MSA, 2007) (15-35°C at pH6). Conformation classification had no effect on any instrumental meat quality parameter. However carcasses with a high fat classification (4H) had a higher Warner Bratzler shear force (WBSF) value than animals of a lower fat classification (1 and 2). Carcasses with high fat classifications (3 and 4L) also had higher carcass temperatures at pH 6, indicating heat shortening although all carcasses were tenderstretched with sarcomere lengths greater than 2mm.

In conclusion these studies demonstrate that finishing beef cattle offered legume/cereal wholecrop silages had 0.18 lower liveweight gain and 0.24 lower carcass gain relative to offering high quality grass silage. This was mainly attributed to the poor fermentation characteristics of the legume/cereal wholecrop silage. It is recommended that beef producers should place increased emphasis on making good quality grass silage rather than legume/cereal wholecrop silages to optimize performance and reduce feed costs in finishing beef systems. The relationships between carcass characteristics and instrumental meat quality indicate that fat content of the carcass has a greater effect on instrumental meat quality that dietary effects *per se*. The inclusion of legume/cereal wholecrop silage or red clover silage in the diet of finishing beef steers or dairy cross heifers had no beneficial effect on FA composition of lean.
Published Papers:

1. P. Kennedy et al. Instrumental meat quality and fatty acid composition of lean muscle from beef steers offered grass silage alone or in combination with legume/cereal based wholecrop silage at two concentrate levels Advances in Animal Biosciences Vol 1 Iss 01 April 2010, p 138-138
   http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=7927526

2. P. Kennedy et al. The effect of offering grass silage alone or in combination with legume: cereal wholecrop silage on methane emissions of Holstein steers Advances in Animal Biosciences Vol 1 Iss 01 April 2010, p 257-257
   http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=7927766