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Integrating Free-Range Hens into a Regenerated Medic Pasture

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Abstract: In Australia some grain farmers, market gardeners and graziers integrate hens into their farming system. In this system, hens are unrestricted in their movements except that they are usually locked in sheds at night for protection from predators. Consumers pay a premium for eggs and chicken meat on the grounds of enhanced welfare of hens in this system. The purpose of this experiment was to determine the impact of hens integrated into a regenerated medic pasture on pasture availability, prevalence of weeds and soil fertility before and after grazing. Sheep were used as a comparison in the experiment. Laying hens stocked at 110/ha (compared to sheep-stocking density 12/ha) foraged on a regenerated medic pasture for 16 weeks. Egg production of 67.8% for free-range hens at week 60 was lower compared to the industry cage standard (83.0% at the same age). However, the live weight of free-range hens (2.3kg) was higher than the cage standard (2.0kg). Herbage availability in hen paddocks after grazing was considerably higher ($P<0.05$) than in sheep paddocks. Hens ingested less ($P<0.05$) barley grass (2.6 vs. 0.3 no./0.1m^2) and other grass (4.2 vs. 0.5 no./0.1m^2) compared to sheep. Paddock soil nitrate nitrogen was lower ($P<0.05$) for both hens (30.7 before grazing vs. 0.4 mg/L after grazing) and sheep (28.2 before grazing vs. 1.2 mg/L after grazing). The penetrometer readings were significantly increased ($p<0.01$) in sheep paddocks (3.9 before grazing to 9.1 after grazing) and in hen paddocks ($P<0.05$) (3.0 before grazing to 4.8 after grazing).

Key words: Hens, free-range, sheep, grazing, regenerated medic pasture, farming systems

Introduction

Integrating hens into a traditional crop and pasture rotation system may be one way to control weeds, diseases and improve soil fertility in cropping areas due to the hen's ability to consume weed seeds, herbage and invertebrates (Tadelle and Ogle, 2000; Lomu *et al*., 2004). Currently consumers are demanding products from free-range systems (http://www.free-rangepoultry.com/compare.htm) because there is a perception that hens from free-range systems are healthier and produce a higher quality product. Lopez-Bote *et al*. (1998) suggested that the chemical composition of grass enhances the n-3 fatty acid content of the eggs. Furthermore, to improve welfare, hens should be able to move freely and express their normal behaviours. For example, hens can engage in sunbathing under natural sunlight compare to largely artificial light under intensive conditions. This experiment was conducted to determine the performance of hens (110 hens/ha) integrated into a regenerated medic pasture and the subsequent effects on herbage availability, weeds and soil fertility. Hens were compared to sheep (12 sheep/ha) which are traditionally used in the crop and pasture farming system in Australia.

Materials and Methods

The rationale for the trial was to determine if hens could be used to graze a regenerated medic pasture which was part of the pasture and cropping rotation on the Roseworthy Campus farm. Hens and sheep were allowed to forage on regenerated medic pasture from July to December 2002. Comparisons of herbage availability, soil fertility and weed control were made between the animal species before and after grazing. This followed previous experiments where hens and sheep foraged a paddock sown with medic (Glatz *et al*., 2005) and then a wheat crop (Miao *et al*., 2005).

Paddocks: A 4ha paddock located at Roseworthy campus, the University of Adelaide was used for this experiment. Regenerated medic pasture was available for both hens and sheep to graze in July 2002.

Housing: An eco-shelter (3m x 3m) was built in the centre of a 4ha paddock. The eco-shelter had four internal pens of equal size each capable of housing 55 hens (20 weeks-of-age, Hyline Brown). The paddock was fenced into 8 plots with 0.5 ha/plot. Hens grazed in 4 plots, and sheep (6 Merino wethers/plot) grazed in the other 4 plots. Throughout the grazing trial, hens were fed twice daily. Half of the layer ration (55 g/hen) was fed in the morning and the other half (55 g/hen) in the evening. Hens were locked in the shelter over night.

Table 1: The liveweight and egg weight of the free-range hens vs. the cage standard at different ages

Age of hens (weeks)	Liveweight (kg)		Egg weight (g)		
	Free-range	Standard	Age of hens (weeks)	Free-range	Standard
46	2.4	2.0	45	64.1	64.8
51	2.2	2.0	49	64.7	65.2
55	2.2	2.0	53	64.0	65.6

Table 2: The mortality and hen-day production of laying hens foraging on regenerated medic pasture compared to the cage standard

Age of hens (weeks)	Hen-day production (%)		Mortality (%)	
	Free-range	Standard	Free-range	Standard
48	76.9	89.0	1.0	1.5
52	79.4	87.0	5.8	1.8
56	81.0	85.0	61.0	2.0
60	67.8	83.0	90.3	2.3

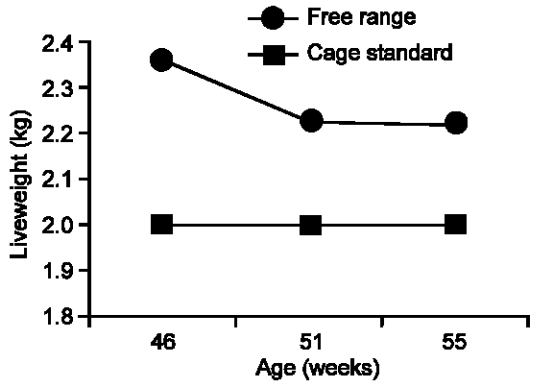

Fig. 1: Live weight (kg) of free-range hens vs. Cage standard

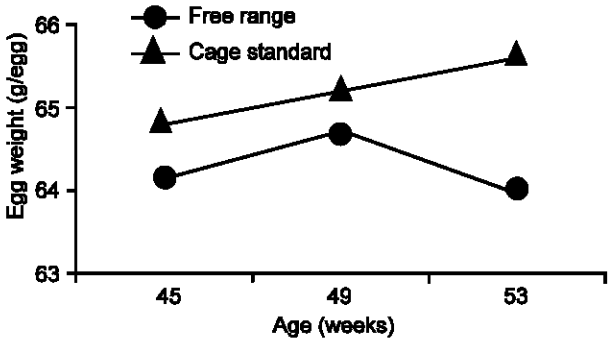

Fig. 2: The average egg weight of free-range hens vs. Cage standard

Measurements: Detailed information on measurements undertaken including hen production, sampling soil and forage (pasture, weeds, seeds and pods), chemical composition of herbage, soil pH (in water and in 0.01M CaCl), soil nitrate_N, ammonia_N and penetrometer measurements are provided in Glatz *et al.* (2005).

Experimental Design and Statistical analysis: The treatments in the experimental paddocks were arranged in a randomized design. Animals and grazing period were the main treatment factors. The treatment effects were assessed with ANOVA in Systat software (Wilkinson, 1996). Bonferroni's post hoc was used to separate means only if significant main effects were detected by analysis of variance. Bonferroni's post hoc test is a multiple comparison test based on Student's t statistic and adjusts the observed significance level when multiple comparisons are made.

Results

Performance of hens: The performance of free-range hens (Hyline Brown) was compared with the production specifications published by the Hyline company for their Brown Egg layer strain housed in cages. The live weight of free-range hens at 46, 51 and 55 weeks-of-age foraging on regenerated medic pasture and fed a commercial layer ration were heavier by 400, 200 and 200g respectively compared to the Hyline standard live weight. Egg weight was similar to the cage standard during weeks 45 and 49, but lower for week 53 (Table 1, Fig. 1, 2).

Compared to the standard production recommended by Hyline, the average production rate was lower for free-range hens (76.3%) than the standard (86.0%) from 48-60 weeks-of-age. In the last 4 weeks there was a sharp decline in production (67.8%) relative to the cage standard (83.0%) due to attacks on hens by foxes. Mortality of the free-range hens foraging on the regenerated medic pasture was similar to the standard at week 48, but higher at week 56 and 60. This was because 2 fox attacks on hens during this period resulted in a sharp increase in mortality (Table 2, Fig. 3, 4).

Table 3: Herbage availability, medic and wheat seed numbers for hen and sheep paddocks before and after grazing on the regenerated medic pasture

	Before grazing				After grazing			
	Poultry	Sheep	P value	SEM	Poultry	Sheep	P value	SEM
Total biomass (60°C) (g/m^2)	165.8	128.3	0.117	14.48	526.1	178.3	0.001	40.94
Herbage (only) wt. (60°C) (g/m^2)	137.8	99.5	0.026	9.21	419.0	139.8	0.001	32.25
Pod no. (no/0.1m^2)	48.1	2.8	0.013	9.25	811.4	4.7	0.007	141.38
Pod wt. (60°C) (g/m^2)	2.3	0.3	0.049	0.57	34.7	0.6	0.005	5.65
Other seed no. (no/0.1m^2)	12.5	1.4	0.124	4.40	443.6	80	0.124	143.89
Other seed wt. (60°C) (g/m^2)	0.4	0.1	0.223	0.195	8.3	1.2	0.058	2.15
Wheat seeds no. (no/0.1m^2)	0	0	1	0	0	0	1	0
Wheat seed wt. (g/m^2)	0	0	1	0	0	0	1	0
Total forage wt. (60°C) (g/m^2)	140.6	99.9	0.025	9.07	462.0	141.6	0.001	34.85
Total herbage DM wt. (g/m^2)	128.2	90.8	0.027	6.98	427.9	132.5	0.001	31.28
Total herbage OM wt (g)	106.4	76.3	0.023	9.68	334.8	101.0	0.002	32.95
	Hen				Sheep			
	Before grazing	After grazing	P value	SEM	Before grazing	After grazing	P value	SEM
Total biomass (60°C) (g/m^2)	165.8	526.1	0.001	39.07	128.3	178.3	0.112	18.96
Herbage (only) wt. (60°C) (g/m^2)	137.9	419.0	0.001	28.27	99.5	139.8	0.166	18.05
Pod no. (no/0.1m^2)	48.1	811.4	0.009	141.6	2.8	4.7	0.680	3.17
Pod wt. (60°C) (g/m^2)	2.3	34.7	0.007	5.68	0.3	0.6	0.458	0.28
Other seed no. (no/0.1m^2)	12.5	443.6	0.078	143.6	1.4	80.0	0.002	10.37
Other seed wt. (60°C) (g/m^2)	0.4	8.3	0.042	2.16	0.1	1.2	0.005	0.18
Wheat seeds no. (no/0.1m^2)	0	0	1	0	0	0	1	0
Wheat seed wt. (g/m^2)	0	0	1	0	0	0	1	0
Total forage wt. (60°C) (g/m^2)	140.6	461.9	0.001	31.37	99.9	141.6	0.153	18.01
Total herbage DM wt. (g/m^2)	128.2	427.9	0.001	27.83	90.8	132.5	0.132	16.93
Total herbage OM wt (g)	106.4	334.8	0.002	31.44	76.3	101.0	0.199	12.09

DM = dry matter, OM = organic matter; P = probability value from analysis of variance; SEM = standard error of mean.

Herbage availability and botanical composition: Before grazing there was no significant (P>0.05) difference between the sheep and hen paddocks in total biomass weight, other seed numbers and seed weight. But there was a significant difference (P<0.05) in herbage weight, pod numbers and pod weight, total herbage weight, dry matter and organic matter availability between the sheep and hen paddocks before grazing. This resulted from the previous differences observed in poultry and sheep grazing medic pasture (Glatz *et al.*, 2005) and wheat stubble (Miao *et al.*, 2005). After grazing the hen paddocks had a significantly higher (P<0.01) total biomass, herbage weight, pod number and pod weight and total forage weight except for other seed numbers and other seed weight (Table 3). This can be explained by the rapid growth of pasture during the experimental period. This was indicated by the increase in total biomass, herbage weight, pod number and pod weight, other seed number and other seed weight and total forage weight in sheep paddocks after grazing.

Weed control: There was no significant (P>0.05) difference in numbers of wheat, barley, rye, other grass, caltrop, potato, mustard, soursob and other broad leaf weed seeds. The exception to this was the significantly higher (P<0.05) number of wire weed and medic pasture in paddocks before grazing by hens and sheep. Paddocks foraged by hens had more barley grass (2.61 vs. 0.33 no./0.1m^2) and other grass (4.22 vs. 0.47 no./0.1m2) than paddocks grazed by sheep. However, no significant (P>0.05) difference was found in wheat, rye, potato seed numbers and other broad leaf weeds after grazing by hens or sheep (Table 4).

Soil fertility and penetrometer readings: There was no significant (P>0.05) difference between hen and sheep paddocks both before and after grazing in nitrate, ammonia and pH (Table 5). Likewise there was no significant (P>0.05) difference in the penetrometer reading between hen (3.0) and sheep (3.9) paddocks before grazing, but there was a significant difference in penetrometer readings (P<0.01) between hen (4.8) and sheep (9.1) paddocks after grazing. However, nitrate level was significantly (P<0.01) decreased for hen (30.7 vs. 0.4 mg/L) paddocks and for sheep (28.2 vs. 1.2 mg/L) paddocks after grazing compared to before grazing. This may be because nitrate nitrogen was taken up by the pasture plants as there was considerable growth of herbage during the experimental period.

Discussion

Hen performance

Live weight: The free-range hens foraging on regenerated medic pasture were heavier than the Hyline

Table 4: Numbers of weeds and seedlings (no./0.1m^2) in paddocks before and after hens and sheep grazed on a regenerated medic pasture

	Before grazing				After grazing			
	Chicken	Sheep	P value	SEM	Chicken	Sheep	P value	SEM
Wheat	9.92	4.47	0.200	2.674	0.03	0.03	1.000	0.028
Rye	128.69	132.56	0.899	20.677	14.89	4.39	0.055	3.122
Barley	0	0.53	0.356	0.373	2.61	0.33	0.015	0.478
Other grass	0.03	0.06	0.670	0.044	4.22	0.47	0.006	0.647
Wire weed	0.64	0.03	0.025	0.146	0	0	1	0
Caltrop	0	0	1	0	0	0	1	0
Potato	0	0	1	0	0.06	0	0.356	0.039
Medic pasture	19.53	1.97	0.020	3.946	0	0	1	0
Soursob	4.81	3.83	0.665	1.510	0	0	1	0
Mustard	0	0	1	0	0	0	1	0
Other broad leaf weeds	0.86	1.64	0.365	0.562	0.088	0	0.356	0.059

P=probability value from the analysis of variance. SEM=standard error of the mean.

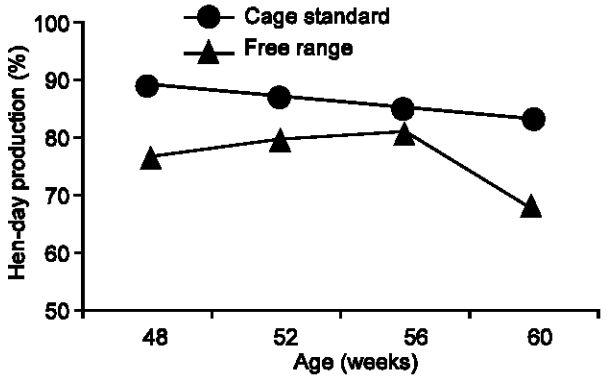

Fig. 3: The henday production of free-range vs. Cage standard

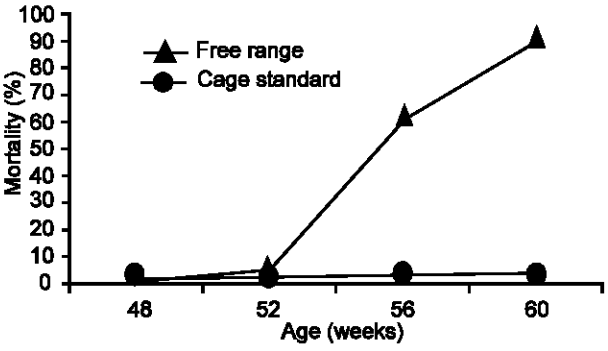

Fig. 4: The mortality of free-range hens vs. Cage standard

cage standard. However their live weight decreased from week 46-51. This may be because there was dilution of the energy intake consumed by hens due to low AME value of regenerated medic pasure (AME 0.8 MJ/kg for poultry; Hughes unpublished data). In addition there was greater fluctuation in temperature in the outdoor environment compared to a cage environment.

Egg production: Compared to standard cage production (87%) recommended by Hyline, the free-range hens had lower egg production (79.1%) from weeks 48-56 (before fox attacks). This result was similar to that reported by Folsch *et al.* (1988), who reported egg production of free-range hens was 75% and feed intake was 120g/day/hen. However, Gibson *et al.* (1984) reported that from 20-72 weeks of age, production was similar for free-range hens (283) and caged hens (280), but feed intake (142.9 vs. 123.0 g/day/hen) was higher for free-range hens than caged hens at 70 weeks (Gibson *et al.*, 1984). The hens in our study also consumed forage and insects (Lomu *et al.*, 2004), which possibly reduced the amount of supplementary feed consumed. However, the egg production of hens in our study declined sharply to 67.8% after fox attacks compared to the cage standard of 83.0% at week 60. In addition to death from injuries, a large number of the hens appeared to die as a result of the severe stress of being chased by the fox.

Egg weight: Egg weight of free-range hens over 46-55 weeks of age was similar compared to the standard (64.3 vs. 65.2g). This result was supported by Mostert *et al.* (1995), who also found that egg weight from hens in the free-range and cage system was similar (60.5 vs. 61.0g). However, the feed conversion (kg feed/kg eggs) was poorer for hens in the free-range (2.6) compared to the standard reported for hens in the cage system (2.3).

Mortality: Mortality of the free-range hens foraging on the regenerated medic pasture was similar to the cage standard for weeks 48 and 52 (1.0, 5.8 vs. 1.5, 1.8% respectively). This result was supported by Gregory (2005), who reported that the prevalence of cannibalism was 5.2% for the free-range and 9.2% for conventional

Table 5: Soil nitrate, ammonia, pH and penetrometer readings for hens and sheep before and after grazing on regenerated medic pasture

Animal	Nitrate (mg/L)	Ammonia (mg/L)	pH (water)	pH ($CaCl_2$)	Penetrometer reading
Before grazing					
Chicken	30.7	4.5	7.2	6.4	3.0
Sheep	28.2	3.3	6.7	5.8	3.9
P value	0.67	0.51	0.47	0.41	0.20
SEM	3.79	1.16	0.50	0.47	0.33
After grazing					
Chicken	0.4	4.7	7.3	6.5	4.8
Sheep	1.2	10.7	7.0	6.1	9.1
P value	0.17	0.26	0.52	0.46	0.00
SEM	0.39	3.45	0.32	0.36	0.83
Hen					
Before grazing	30.7	4.5	7.2	6.4	3.0
After grazing	0.4	4.7	7.3	6.5	4.8
P value	0.00	0.93	0.87	0.87	0.01
SEM	2.44	1.66	0.40	0.39	0.31
Sheep					
Before grazing	28.2	3.3	6.7	5.8	3.9
After grazing	1.2	10.7	7.0	6.1	9.1
P value	0.00	0.16	0.61	0.67	0.00
SEM	2.92	3.24	0.44	0.45	0.39

P = probability value from the analysis of variance. SEM=standard error of the mean.

cage hens. However, 2 fox attacks in the last 4 weeks in our trial resulted in a sharp increase in mortality. Locking birds in the shelter at night and building a fence of sufficient height could prove effective in averting the fox problem.

Agronomic aspects

Herbage availability and weed control: Compared to the sheep paddocks, the herbage availability was much higher for hen paddocks (Glatz *et al.*, 2005; Miao *et al.*, 2005). This was expected as hens only ingest small amounts of herbage (Lomu *et al.*, 2004). Herbage availability was also increased in sheep paddock. This may be because the herbage growing season occurred during the experimental period. Hens also ingested more wheat, barley and rye seeds, but sheep ingested more medic clover pods, wire weed and other grass seeds. This raises the possibility that sheep and hens could be co-grazed in some circumstances, to provide a method for reducing weeds; using sheep to graze weeds they prefer and hens to consume weed seeds that sheep avoid.

Soil fertility and penetrometer reading: When direct comparisons were made of sheep and hen paddocks no significant difference could be found in soil fertility, pH before and after grazing although sheep tended to have a higher level of soil ammonia nitrogen after grazing. Soil nitrate nitrogen content was significantly lower in both hen and sheep paddocks after grazing compared to before grazing. This may be because the soil nitrate nitrogen was taken up by plants as there was rapid growth of herbage during the experimental period. The significant increase in penetrometer readings in the sheep paddocks may indicate that sheep continually trample the forage resulting in an increase in penetrometer readings in the soil.

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