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Integrating Free-Range Hens into a Wheat Stubble

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Abstract: Some grain farmers, market gardeners and graziers integrate hens into their farming system in Australia. In this system, hens move freely around the farm except that they are usually locked in sheds at night for protection from predators. Consumers pay a premium for eggs due to enhanced welfare of hens in a free-range system. The purpose of this experiment was to compare the impact of hens vs. sheep when integrated into a wheat stubble in a crop and pasture rotation system. The stubble availability, weeds and soil fertility were measured before and after grazing. Laying hens stocked at 110/ha (compared to the sheep stocking density of 12/ha) were allowed to forage on the wheat stubble. The performance of the free-range hens was excellent with production averaging 90%. Free-range hens were heavier than Hyline standard (2.09 vs. 1.99 kg) at week 33. Hens foraged extensively in the wheat stubble over the foraging period from January to May. Generally, paddocks foraged by hens had more stubble remaining compared to paddocks grazed by sheep. Hens preferred rye seeds, while sheep preferred other grass, wire weed, medic pods and other broad leaf weeds. There was no effect of grazing on soil pH with this low stocking density of both sheep and hens but soil nitrate levels were higher (6.69 vs. 39.90 mg/L for sheep and 7.80 vs. 32.98 mg/L for hens) after grazing, suggesting that animal droppings were contributing to the increase. This trial indicates that integrating hens into crop and pasture rotation system could assist in weed control and increase soil fertility.

Key words: Hens, free-range, sheep, wheat stubble, 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. Under natural conditions, a hen's diet comprises seeds, fruits, herbage and invertebrates and could partly achieve a reduction in problem insects and weed seeds (Tadelle and Ogle, 2000; Lomu *et al*., 2004). Hens can also clean up the grain spilt from headers during the harvest. In addition, consumers are also beginning to demand products from free-range animal production systems (http://www.free-rangepoultry.com/compare.htm). Furthermore, for the "best positive welfare outcome", hens should be free from hunger, thirst, discomfort, pain, injury, disease, fear and distress and able to express normal behaviours (Brambell, 1965). In particular, free-range systems allow hens to move freely and to express their normal behaviour. This experiment was conducted to determine the performance of hens integrating into a wheat stubble and subsequent effects on herbage availability, weeds and soil fertility. Hens were compared to sheep 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 the surplus forage in a wheat stubble which was part of the crop and pasture rotation system on the Roseworthy Campus farm. After a wheat harvest, hens and sheep were allowed to forage on the mulched wheat stubble from January to May 2002. Comparisons in herbage availability, soil fertility and weed control were made between the animal species before and after grazing.

Paddocks: A 4 ha paddock located at Roseworthy campus, the University of Adelaide was used for this experiment. Wheat stubble was available after a wheat crop was harvested in December 2001.

Housing: An eco-shelter (3m x 3m) was built in the centre of a 4 ha 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

Measurements: Detail 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 $CaCl_2$), soil nitrate N, ammonia N and penetrometer are provided in Glatz *et al*. (2005).

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

Age of hens (weeks)	Live weight (kg)	Standard (kg)	Age of hens (weeks)	Egg weight (g)	Standard (g)
24	1.94	1.78	24	54.3	57
28	1.93	1.93	28	55.7	61.3
33	2.09	1.99	32	58.2	62.7
			36	61.6	63.7

Table 2: The mortality and hen-day production (%) of laying hens foraging on wheat stubble vs. Hyline standard

Age of hens (weeks)	Hen-day production (free-range)	Standard production	Mortality (free-range)	Standard mortality
20	7.60	26	0	0.10
24	74.38	93	0	0.30
28	89.35	95	3	0.50
32	91.65	94	4	0.70
36	90.94	93	0	0.90

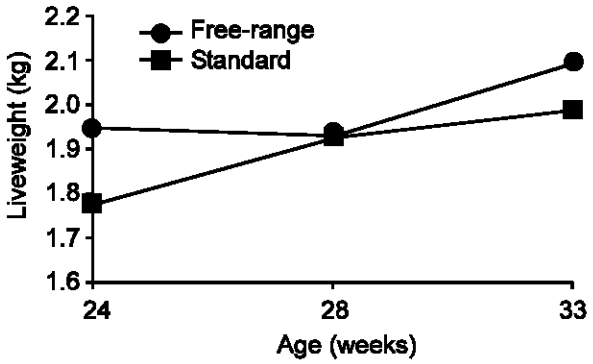

Fig. 1: Comparison of hen live weight (kg) of free-range vs. standard

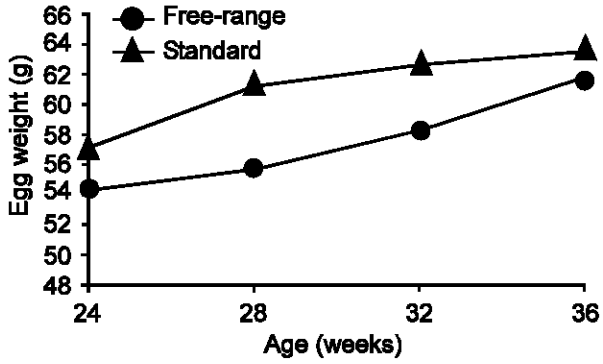

Fig. 2: Comparison of average egg weight of free-range hens vs. standard

Experimental design and statistical analysis: The treatments in the experimental paddocks were arranged in a randomized block design. Animals were the main treatment factor. Date of sampling, pasture type, zone and interactions were also analyzed. 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 statistics and adjusts the observed significance level when multiple comparisons are made.

Results

Performance of hens: The performance of layers (Hyline Brown) in the free-range system 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 foraging on wheat stubble and fed a commercial layer ration were 160 and 100g heavier compared to the Hyline standard live weight at 24 and 33 weeks of age respectively. Egg weight was lower compared to the standard presumably because hens were consuming less protein than required to achieve the recommended standard (Table 1, Fig. 1 and Fig. 2).

Compared to the standard production recommended by Hyline, the free-range hens had a delay in start of lay and in reaching peak production. The average production rate was lower for free-range hens than the standard (70.8 vs. 80.2%) over 20 to 36 weeks-of-age. Mortality of the free-range hens was similar to the standard (Table 2, Fig. 3 and Fig. 4).

Herbage availability and botanical composition: Before grazing there was no significant difference ($P>0.05$) between the sheep and hens paddocks in total dry biomass weight, herbage weight, pod number, total herbage weight, dry matter and organic matter availability in the paddocks. The exception to this was a significant difference ($P<0.05$) in pod weight between sheep and hens paddocks. After grazing the hen paddocks had a significantly higher ($P<0.01$) number of medic pods (215 vs 8.1 no/0.1m^2), pod weight (11.2 vs 0.5 g/m^2), other seed weight (10.1 vs 1.6 g/m^2) and a significantly higher ($P<0.05$) number of other seeds (451.7 vs 97.5 no/0.1m^2) and total herbage weight (410.5 vs 237.8 dried at 60^{o}C) (Table 3). Hens foraged a small amount of herbage but not medic pods, while sheep grazed more herbage and medic pods.

Weed control: There was no significant difference ($P>0.05$) in wheat, barley, rye, other grass, caltrop, potato, medic clover, mustard and other broad leaf weed seeds except for wire weed (2.39 vs. 0.06 no./0.1m^2) ($P<0.01$) after grazing by hens or sheep. There was a

Table 3: Comparison of herbage availability, medic and wheat seed numbers, dry matter and ash in hen and sheep paddocks before and after grazing on wheat stubble

Animal	Total biomass (60°C) (g/m^2)	Herbage (only) wt. (60°C) (g/m^2)	Medic pod No. ($No/0.1m^2$)	Pod wt. (60°C) (g/m^2)	Other seed no. ($No/0.1m^2$)	Other seed wt (60°C) (g/m^2)	Wheat seed no. ($No/0.1m^2$)	Wheat seed wt. (g/m^2)	Total herbage wt. (60°C) (g/m^2)	Total DM wt. (herbage) (g/m^2)	Total OM wt. (herbage) (g/m^2)
Before grazing											
Poultry	530.1	431.0	93.1	5.6	625.8	20.1	0	0	456.7	433.3	359.1
Sheep	545.0	487.6	26.1	1.1	414.4	10.6	0	0	499.3	471.5	384.6
P value	0.748	0.125	0.108	0.040	0.479	0.313	0	0	0.278	0.302	0.453
SEM	31.35	22.45	25.07	1.22	197.89	6.12	0	0	25.25	23.87	22.55
After grazing											
Poultry	473.8	389.2	215.0	11.2	451.7	10.1	0	0	410.5	384.6	281.6
Sheep	302.2	235.6	8.1	0.5	97.5	1.6	0	0	237.8	223.6	173.2
P value	0.071	0.061	0.007	0.005	0.017	0.005	0	0	0.045	0.045	0.061
SEM	55.42	47.23	36.58	1.73	77.07	1.37	0	0	48.51	44.93	33.32
Hen											
Before grazing	530.1	431.1	93.1	5.6	625.8	20.1	0	0	456.7	433.3	359.1
After grazing	473.8	389.2	215.8	11.2	451.7	10.1	0	0	410.5	384.6	281.6
P value	0.50	0.49	0.09	0.10	0.54	0.26	0	0	0.48	0.43	0.12
SEM	55.75	40.22	42.47	2.02	190.74	5.74	0	0	43.71	40.79	30.93
Sheep											
Before grazing	545.0	487.6	26.1	1.1	414.4	10.6	0	0	499.3	471.5	384.6
After grazing	302.2	235.6	8.1	0.5	97.5	1.6	0	0	237.8	223.6	173.2
P value	0.001	0.002	0.36	0.54	0.05	0.05	0	0	0.001	0.001	0.001
SEM	30.75	33.42	12.78	0.61	93.37	2.53	0	0	32.87	30.42	25.73

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

trend for more medic pasture, other grass, soursob and other broad leaf weeds in the hen paddocks, which more rye seeds were found in the sheep paddocks (Table 4).

Soil fertility and penetrometer readings: There was no significant difference ($p>0.05$) between hen and sheep paddocks both before and after grazing in soil nitrate N, ammonia N and pH (Table 5). Likewise there was no significant difference in penetrometer reading between hens and sheep paddocks both before grazing (1.44 vs 1.04 respectively) and after grazing (1.87 vs. 2.47 respectively). However, penetrometer readings were significantly increased ($P<0.05$) for sheep paddocks after grazing (1.04 vs. 2.47). No significant difference ($P>0.05$) was found in hen paddocks after grazing (1.44 vs. 1.87). Nitrate N level was significantly increased ($P<0.05$) (32.90 vs. 7.80 mg/L) for hen paddocks and (39.90 vs. 6.69 mg/L) for sheep paddocks after grazing. No significant difference ($P>0.05$) was found for ammonia N, pH and penetrometer after grazing for both hen and sheep paddocks (Table 5).

Discussion

Hen performance

Egg production: Compared to the standard production recommended by Hyline, the free-range hens had a slight delay in reaching maturity and peak production presumably because they were exposed to a decreasing light pattern from January-May 2002. Hens were not provided artificial light in the shelter. Consequently hens did not receive the day length required to

Table 4: Weight of weed seeds in poultry and sheep paddocks after grazing on wheat stubble (no./0.1m^2)

Weed seed	Hen	Sheep	P value	SEM
Wheat	4.28	4.06	0.937	1.910
Rye	6.42	10.72	0.184	2.026
Barley	0	0	0	0
Other grass	0.81	0.31	0.488	0.479
Wire weed	2.39	0.06	0.001	0.244
Caltrop	0	0	0	0
Potato	0	0	0	0
Medic/clover	5.28	2.67	0.293	1.604
Soursob	0.94	0.61	0.752	0.714
Mustard	0	0	0	0
Other broad leaf weeds	1.31	0.42	0.182	0.417

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

Table 5: Soil nitrate N, ammonia N and pH readings for hens and sheep before and after grazing on wheat stubble

Animal	Nitrate N (mg/L)	Ammonia N (mg/L)	pH (water)	PH ($CaCl_2$)	Penetrometer
Before grazing					
Poultry	7.80	3.51	7.54	6.74	1.44
Sheep	6.69	5.19	6.68	5.81	1.04
P value	0.486	0.277	0.188	0.196	0.50
SEM	1.054	0.993	0.410	0.451	0.27
After grazing					
Poultry	32.98	2.25	7.33	6.38	1.87
Sheep	39.90	6.14	6.34	5.48	2.46
P value	0.266	0.212	0.281	0.230	0.19
SEM	3.991	1.968	0.592	0.479	0.22
Hen					
Before grazing	7.80	3.51	7.54	6.74	1.44
After grazing	32.96	2.25	7.33	6.38	1.87
P value	0.001	0.36	0.75	0.56	0.33
SEM	2.77	0.89	0.45	0.41	0.29
Sheep					
Before grazing	6.69	5.19	6.68	5.81	1.04
After grazing	39.90	6.14	6.34	5.48	2.46
P value	0.00	0.75	0.68	0.66	0.04
SEM	3.06	2.01	0.57	0.51	0.40

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

maximise production. In this study, hens average lay rate from 20 to 36 weeks of age was 70.8%. This result was lower than that reported by Folsch *et al.* (1988), who reported that the lay rate of free-range hens was 75% with feed intake of 120g/day/hen. This difference may be because the feed allowance provided in our trial was 10g/day/hen less. Gibson *et al.* (1984) reported that from 20 to 72 weeks of age, production was similar for free-range hens and cage hens (283 vs. 280). However, feed intake was higher for free-range than cage hens at 36 weeks (152.4 vs. 119.8 g/day/hen) and at 70 weeks (142.9 vs. 123.0 g/day/hen).

Egg weight: Egg weight of free-range hens over 24-36 weeks of age was lighter compared to the standard (average 57.5 vs. 61.2g). This result was different from Mostert *et al.* (1995), who found that egg weight from hens in the free-range and battery system was similar (60.52 vs 60.98g). The feed conversion ratio in our study was 2.73 g feed/g egg. This was supported by Mostert *et al.* (1995), who found the feed conversion was 2.604 for free-range and higher compared to hens in a battery system (2.355). This may because protein intake could be diluted by consuming lower protein forage in free-range (Lomu *et al.*, 2004) or some of the protein was being diverted to energy requirements as hens are generally more active than cage hens when given access to free-range facilities. In addition, egg weight varied between breeds. Isa Brown hens can consume over 130g feed/day and produce eggs over 63g (Thear, 1997).

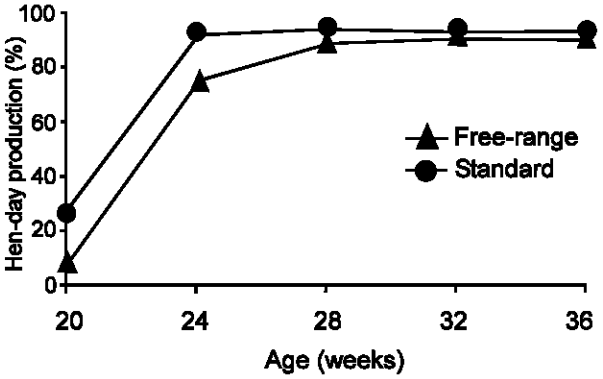

Fig. 3: The hen-day production (%) of free-range hens vs. standard

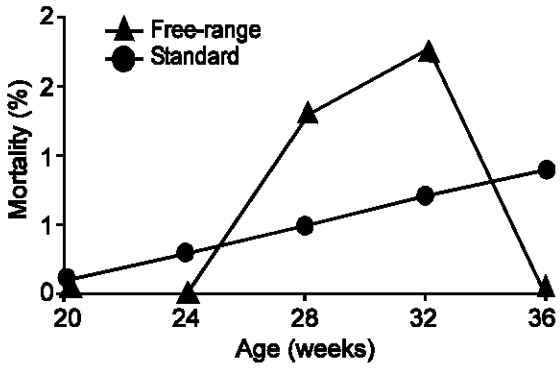

Fig. 4: The mortality (%) of free-range hens vs standard

Live weight: The free-range hens foraging on wheat stubble in our study were heavier than the Hyline standard. This may be because free-range hens probably consumed considerable quantities of spilt grain left after the wheat harvest. Hens were observed ranging extensively in the paddocks during the experimental period.

Mortality: Mortality of the free-range hens was similar to the standard while foraging on the wheat stubble. This result was supported by Gregory (2005), who reported that the prevalence of cannibalism in three trials was 5.2% for the free-range and 9.2% for the conventional cage hens. Hens also roamed widely in the wheat stubble paddock and there was little evidence of feather pecking and cannibalism.

Agronomic aspects

Herbage availability and weed control: Compared to sheep paddocks, the herbage availability was much higher for hen paddocks after grazing. This was expected as ruminants ingest more herbage than monogastrics. Also the stocking rate of sheep in the paddock was almost twice that of the stocking rate of hens in the paddock when assessed on a kg/ha basis. The results also showed that hens ingested a small amount of herbage and rye seeds, but sheep ingested more herbage, medic pods, wire weed and other seeds. This result was supported by Lomu *et al.* (2004), who found that the seeds, herbage and insects were present in the hen's crop. This raises the possibility that sheep and hens could be grazed together 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 difference could be observed in soil fertility, pH before and after grazing although sheep tended to have a higher level of soil ammonia and pH. Nitrate content was significantly higher in both hens and sheep paddocks after grazing compared to before grazing. This indicated that when integrating hens into this farming system, soil fertility could be improved by the nitrogen output from hens. After sheep had grazed the wheat stubble paddocks there was an increase in penetrometer readings in the paddocks. This reflects the trampling effect that sheep have on forage and soil with continued grazing whereas hen paddocks showed no change in penetrometer readings. Hens scratch the soil and loosen it ensuring the surface soil does not get hard.

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