



Resilient plants to entice hens outdoors on free range farms- Case study farms

A report for Australian Eggs Limited by C.T. de Koning

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Case study farms

Case studies were based on fixed range free range farms, whereby the focus was on what was planted/growing on the range and how the farms managed ground cover and trees. The case study farms were located in different climatic zones and were visited up to twice per year corresponding with flocks at peak lay and when the flocks had matured prior depopulation. Five farms were visited during 2018 and 2019.

On two of the case study farms (Farm 1 and 2), flocks were selected that had started ranging. Plumage condition and beak shape score were assessed as an indication of the level of feather pecking within a flock. Flocks had plumage scores made on 100 randomly selected birds at different locations within the shed and 100 randomly selected birds across the different areas of the outdoor range. The AssureWel (<http://www.assurewel.org/layinghens/featherloss>) score system was used, whereby;

0 = no or minimal feather loss (no bare skin visible, no or slight wear, only single feathers missing),

1 = slight feather loss (moderate wear, damaged feathers or 2 or more adjacent feathers missing, bare skin visible <5 cm maximum dimension).

2 = moderate/severe feather loss (bare skin visible ≥ 5 cm maximum dimension).

Scores were made across five different body parts of the hen which included; head/neck, back, base of tail/around preen gland, the tail and wings. A total plumage score was calculated for each hen by adding the five body part scores together (maximum score = 10).

Beak shape scores were also taken and based on the percentage of acceptable beak shapes 3 + 4 + 5, from the manual by Glatz and Runge (2017), "Managing Fowl Behaviour - A best practice guide to help manage feather pecking and cannibalism in pullet, layer and breeder flocks." published by Australian Eggs. Fifty hens selected at random from throughout the shed and 50 hens selected at random outdoors were beak scored.

Farm 1 – Temperate (Mediterranean) climatic zone

Average Annual Rainfall & Rainfall pattern; 470 mm, winter dominant rainfall pattern.

Rainfall total 2018 = 250 mm.

Rainfall total 2019 = 252 mm

Soil type; Typically Red Brown Earths have a topsoil of sandy loam to light clay loam overlying a clay subsoil. Soil pH measured in CaCl₂ is 6.6 – 7.0 (0 – 30 cm), 7.6 – 8.0 (30 – 60 cm) and 8.1 – 9.5 (60 – 100 cm). Soil pH measures for farms 1, 2, 4 and 5 were obtained from, <https://www.nationalmap.gov.au/investormap/> Farm 3 provided their own soil pH measurements.

Length of time the farm has been operating; The farm has been running free range layers for over 50 years as part of a broad acre cropping-livestock enterprise. The case study flocks' range area and shed is approximately 5 - 6 years old.

Range size, range shape, locality of the shed within the range area; The shed is located in the centre of a square shaped range area that caters for up to 1,500 hens per hectare. The range area is subdivided into four sections.

Orientation of shed; East – West.

Shed type (1-sided or 2-sided pop-holes); The entire lower half of the North and South facing sides of the shed open to allow hens access to the range.

Additional structures (eg. shade shelters, hay bales) on the range; Shade shelters are located 5 m from the shed on the North and South side of shed.

Flock size and flock age; Total flock 5,000 Hy-line Brown hens (Infra-red beak treated at hatchery), divided into two sub-flocks of 2,500 hens each. The shed was sub-divided down the middle lengthwise and each sub-flock had access to their own range area. Case study visits in 2018 were made when the hens were 32 and 65 weeks old (Flock A). In 2019, the second flock hens were 25 and 41 weeks old during visits (Flock B).

Outdoor stocking density; Up to 1,500 hens /ha.

Observations from farm visits

Percentage of total flock on the range, where on the range and what is the main activity of the hens, and weather conditions at time of visit.

2018: The maximum percentage of the flock outside during the case study visits was 12.5%.

May 2018: Most of those hens outside were on the southern side of the shed in the shade cast by the shed. The northern side was more exposed to a moderate northerly wind on the day of the visit.

December 2018: As a result of strong SW winds gusting up to 40 km/hr over 60% of those hens outside were foraging and dustbathing on the northern side within 10 m from the shed.

July 2019: Seventy-five percent of the flock were outdoors on both sides of the shed, with 20% of the flock at least 10 m away from the shed foraging. The temperature was 14°C with no breeze and the ground was damp from overnight rain.

November 2019: Less of the flock was outdoors with 35% of the flock on the range and 8% of the flock venturing at least 10 m from the shed. The wind was a strong SW at 30 km/hr with a temperature of 16°C.

Plumage condition score and beak shape scores of hens on the range and indoors;

Table 1; Farm 1 - Flock A, year 2018, average total plumage scores and beak scores of free range Hy-line Brown hens at 32 and 65 weeks stocked at 1,500 hens/ha.

	Hen age (32 weeks)		Hen age (65 weeks)	
	Plumage	Beak *	Plumage	Beak *
Range	0.23	94	0.98	92
Indoor (Shed)	0.28	98	1.29	98
Statistical significance	n.s	-	P < 0.01	-

*Beak shape score (percentage of acceptable beak shapes 3 + 4 + 5) based on; Glatz P, Runge G (2017) Managing Fowl Behaviour - A best practice guide to help manage feather pecking and cannibalism in pullet, layer and breeder flocks. Australian Eggs, 148 pages.

Plumage condition of flock A in 2018 at 65 weeks was very good, even so those hens on the range had better plumage condition compared to those hens in the shed (Table 1). Most of the plumage damage was on the tail followed by the neck. Beak shape scores had shown the overall flock average was 96% and 95% at 32 and 65 weeks respectively. This is just below the recommended level of 97% for the age of flock (Glatz and Runge 2017). Interestingly, the birds outdoors were below the recommended level while those hens indoors were above. There were proportionally more birds outdoors with a beak shape score of 6. Better plumage scores of birds outdoors at age 65 weeks may be partly attributed to more birds outdoors with beak score shape 6. Beak shape 6 with a larger beak step would make it more difficult for those birds to effectively peck at other birds.

As hens had extremely good plumage feather scores were not made for the 2019 flock B at age 25 and 41 weeks and only beak scores were assessed. Similarly to the previous flock in 2018, flock B had a greater percentage of acceptable beak shapes for those birds inside the shed compared to outdoors (Table 2).

Table 2; Farm1 – Flock B, year 2019, beak scores of free range Hy-line Brown hens at 25 and 41 weeks stocked at 1,500 hens/ha.

	Hen age (25 weeks)*	Hen age (41 weeks)^
Range	82 %	86%
Indoor (shed)	94 %	96%

Beak shape score * (percentage of acceptable beak shapes 3 + 4 + 5 + 6, birds 12 to 30 weeks of age) and ^ (percentage of acceptable beak shapes 3 + 4 + 5, birds 30< weeks of age) based on; Glatz P, Runge G (2017) Managing Fowl Behaviour - A best practice guide to help manage feather pecking and cannibalism in pullet, layer and breeder flocks. Australian Eggs, 148 pages.

The beak shape score distributions were also different between indoor birds and outdoor birds (Figure 1). Proportionally more birds are found on the range with a larger beak step (score 7 at 25 weeks & score 6 at 41 weeks) and more birds with score 4 inside the shed. This is similar to the 2018 flock A.

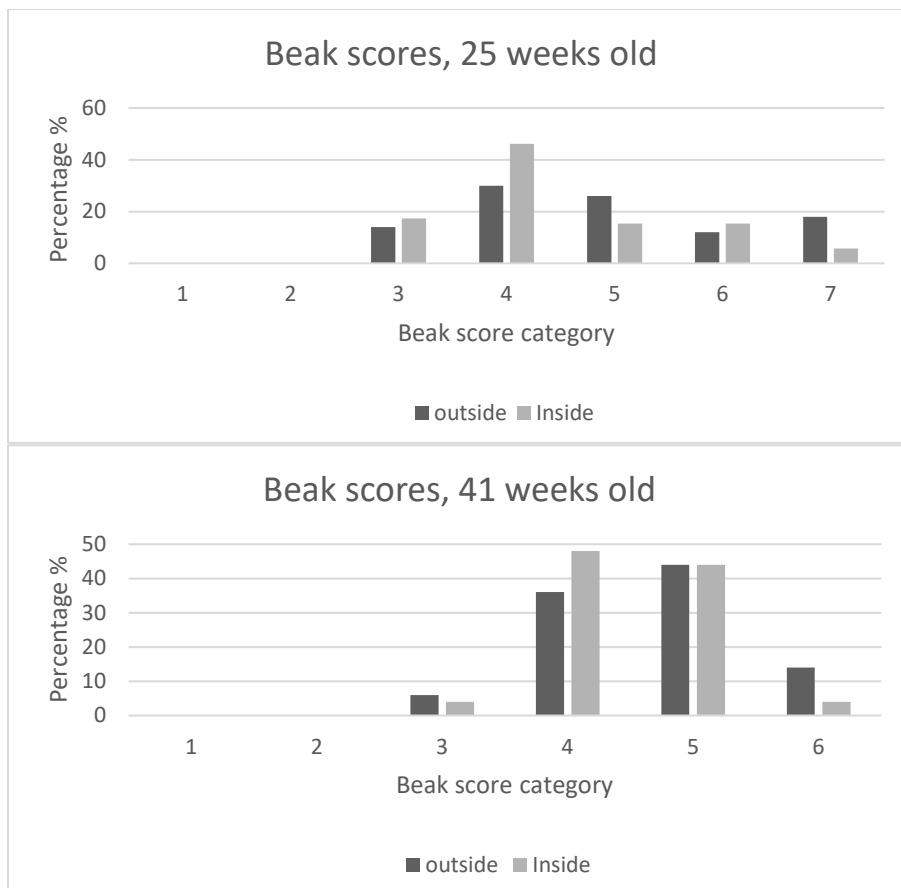


Figure 1. Beak shape score distribution for the 2019 flock B at 25 and 41 weeks old.

Ground cover plant species including weed species on the range; 2018 - Lucerne (*Medicago sativa*) had been sown extensively on the range areas of Farm 1 (Figure 2). A naturalised annual form of saltbush, lagoon saltbush (*Atriplex suberecta*) was also found growing on the range and this plant was most commonly found growing closest to the shed, albeit very well grazed down by the hens. Very few weeds were found and they grew closer to the shed at 10 m and 20 m. Lucerne was dominant at 40 m and beyond with no weeds at this distance from the shed. Weed species included wild mustard (*Sinapis arvensis*), marshmallow (*Malva parviflora*) and wire weed (*Polygonum aviculare*). At 20 m from the shed, lucerne and lagoon saltbush were growing in combination.

Condition of the ground cover vegetation on the range; 2018 - In December 2018, green ground cover was 8% at 10 m to 20 m from the shed and 14% at 40 m from the shed. Drought conditions during 2018 had a significant impact on lucerne growth. However, if not for the lucerne and the lagoon saltbush, there would not have been any green ground cover. Pasture height was taller furthest from the shed. Yet, hens had been actively foraging away from the shed as the height of lucerne had decreased from 25 cm tall at 32 weeks down to 15 cm at 65 weeks at a distance of 40 m. The range area surrounding the shed was bared out to around 10 m.

2019 – The area rested during 2018 was opened for flock B during 2019, while the area ranged during 2018 was closed for recovery until November 2019. Green ground coverage was high in July 2019, except at 10 m there was 14% cover, while 20 m and 40 m had 84% and 90% cover respectively. Green ground coverage had dropped dramatically by November 2019, whereby at 10 m there was only 8% green cover, 20 m = 11% green cover and 40 m = 18.5 % green cover. This was largely attributed to the annual plant species dying off at this time of the year; a normal occurrence for Mediterranean climatic areas. Lagoon saltbush had made an appearance again in November and was mostly found at 10 and 20 m from the shed. In July Lagoon saltbush was not seen. Lucerne was not dominant in July, other species were present such as marshmallow, annual ryegrass (*Lolium*

rigidum) and Shepherd's purse (*Capsella bursa-pastoris*). However, in November Lucerne was the most dominant species and remained green while the annual plant species (marshmallow, annual ryegrass and Shepherd's purse) had died off (Figure 3). The area rested during 2019 had more green ground cover at 20 m (20% cover) and 40 m (31% cover) from the shed in November 2019 compared to the area that had been ranged throughout 2019 (11% and 18% for 20 m and 40 m respectively).

Tree type, location on the range, number and age of trees; Locally adapted Eucalyptus tree species were planted with at least 60 established trees from 1 m to 6 m tall, with an additional 200 younger trees less than 1 m tall. Trees were planted in 5 rows running parallel to the shed, within a row the trees are planted around 5 m apart. The first tree row is adjacent the shed and runs the length of the shed. Further tree rows are approximately 10 m, 25 m, 40 m and 55 m from the shed and run the full length of the range area. Trees were sourced from "Trees for Life". Newly planted trees are protected with 40 cm tall green corflute tree guards.

Practices used to manage the range vegetation (e.g. rotation time between different areas of the range, frequency of mowing); Following sowing, lucerne is usually given at least 12 weeks to establish before hens are allowed to range on the lucerne. The range area is subdivided so there is the ability to rotate between 2 paddocks for each sub-flock. Lucerne on the case study range is surviving. However, due to the drought the older lucerne stands on the farm will need the lucerne re-sown. Consideration is being given to delay placement of those flocks by 12 weeks to allow those ranges time to establish.



Figure 2: Left – range in autumn 2018 when hens 32 weeks old & Right – early summer 2018 showing Lucerne when hens 65 weeks old.



Figure 3: Left – July 2019 the range had at least 90% green ground cover at 40 m from the shed and Right – November 2019 annual plants have died off leaving green Lucerne plants and an average green ground cover of 18%.

Farm 2 – Temperate (Cool) climatic zone

Average Annual Rainfall & Rainfall pattern; 610 mm, uniform rainfall pattern throughout the year. Rainfall total 2018 = 635 mm. Spring drier than usual.

Rainfall total 2019 = 432 mm.

Soil type; Acidic loam with less acidity at depth. Soil pH measured in CaCl₂ is 5.6 – 6.0 (0 – 5 cm), 4.9 – 5.5 (5 – 15 cm), 5.6 – 6.0 (15 – 60 cm) and 6.1 – 6.5 (60 – 100 cm).

Length of time the farm has been operating; 6 years.

Range size, range shape, locality of the shed within the range area; Square range, 19,000m². The northern range is twice the size of the southern range. There is no eastern range area.

Orientation of shed; East – West.

Shed type (1-sided or 2-sided pop-holes); Pop-holes are located along the North and South facing sides of the shed.

Additional structures (e.g. shade shelters, hay bales) on the range; There were 10, steel framed shade structures (5 x 5 m) with shade cloth. These were located close to the shed when the flock was young and moved progressively further from the shed as the flock matured. Hay bales had been placed on the range, particularly when the green ground cover had disappeared. The hens scratch through the hay breaking it down into smaller pieces potentially adding organic matter to the soil.

Flock size and flock age; year 2018 - Total 14,880 Hy-line Brown hens (Infra-red beak treated at hatchery). Case study visits were made when the hens were 42 and 72 weeks old (Flock C). During 2019 only one visit was made when the hens were 68 weeks old (Flock D).

Outdoor stocking density; Up to 10,000 hens /ha.

Observations from farms visits

Percentage of total flock on the range, where on the range and what is the main activity of the hens, weather conditions at time of visit;

2018: Fourteen percent of flock C were outdoors at the time of the visits. Hens were found across all parts of the range with at least 50% of those hens outdoors beyond 10 m from the shed. Weather conditions at the time of the visits was cool, partly cloudy with a light breeze.

2019: At least 50% of flock D was outdoors. Of those hens outside, 80% were away from the shed in the wattle groves and under the cypress pines along the perimeter fence. There were very few hens using the constructed shelters adjacent to the shed. Weather conditions were sunny, no breeze and 21°C.

Plumage condition score and beak shape scores of hens on the range and indoors;

Table 3; Farm 2 – flock C, 2018, average total plumage scores and beak shape scores of free range Hy-line Brown hens at 42 and 72 weeks stocked at 10,000 hens/ha.

	Hen age (42 weeks)		Hen age (72 weeks)	
	Plumage	Beak *	Plumage	Beak *
Range	1.27	93.0	3.22	93.8
Indoor (Shed)	2.06	94.0	4.43	94.6
Statistical significance	P < 0.001	-	P < 0.001	-

*Beak shape score (percentage of acceptable beak shapes 3 + 4 + 5) based on; Glatz P, Runge G (2017) Managing Fowl Behaviour - A best practice guide to help manage feather pecking and cannibalism in pullet, layer and breeder flocks. Australian Eggs, 148 pages.

Table 4; Farm 2- flock D, 2019, average total plumage score and beak shape scores of free range Hy-line brown hens at 68 weeks stocked at 10,000 hens/ha.

	Hen age (68 weeks)	
	Plumage	Beak*
Range	1.45	86.0
Indoor (Shed)	2.56	94.0
Statistical significance	P < 0.001	-

*Beak shape score (percentage of acceptable beak shapes 3 + 4 + 5) based on; Glatz P, Runge G (2017) Managing Fowl Behaviour - A best practice guide to help manage feather pecking and cannibalism in pullet, layer and breeder flocks. Australian Eggs, 148 pages.

Plumage condition was reasonable considering the age of the hens in flock C. Ranging hens had better plumage condition than shed hens at 42 and 72 weeks (Table 3). At 72 weeks most of the plumage damage was on the neck, back and base of tail. Beak scores differed slightly. Plumage damage scores of birds on farm 2 were higher than farm 1, possibly due to the higher outdoor stocking density. Flock D in 2019 had very good plumage at 68 weeks, considerably better than the previous flock C at 72 weeks of age. Range hens had significantly less plumage damage than hens in the shed. Beak scores differed between range hens and hens inside the shed with a lower percentage of hens with acceptable beak shapes found on the range. This was due to proportionally more hens with beak shape 6 on the range. Similarly, this was found on Farm 1.

Ground cover plant species including weed species on the range; Wire weed (*Polygonum aviculare*) had been the main ground cover plant on the first visit in March 2018, with almost total cover except for bare ground within 5 m from the shed.

Condition of the ground cover vegetation on the range; The flock of 2017 had relentlessly attacked the newly established pasture species of perennial ryegrass (*Lolium perenne*), red clover (*Trifolium pratense*) and white clover (*Trifolium repens*) during the dry season in 2017 (503 mm annual rainfall). This had led to the dominance of the wire weed in 2018. Green ground cover had been denuded from the range by the time of the second visit at 72 weeks (October 2018). The range was lightly cultivated and re-sown in March 2019 with biennial ryegrass (*Lolium multiflorum*), oats (*Avena sativa*) and white clover in preparation for flock D placement in March 2019. Weather conditions were dry and the hens soon targeted the palatable ryegrass.

Tree type, location on the range, number and age of trees; Trees planted on farm 2 are locally adapted native species and were sourced from a local nursery as seedlings. Seedlings are grown on into larger pots (up to 30 cm diameter) in the farm's own simply constructed plant nursery (Figure 4). When the trees reach 1 m tall they are planted out onto the range. At this height, they don't require tree-guards. Tree planting is usually done from March to November, with around 114 newly planted trees in the last 12 months on the case study flock's range. Furthest from the shed along the northern fence line is a row of mature cypress trees. This area of the range has been well utilised by the hens, to the extent that the trees needed their root zone protected with large rocks. Young black and silver wattles (*Acacia mearnsii* and *A. dealbata*) planted on the range were growing particularly well and had reached over 3 m tall in 2 years. Wattles had been planted in circular shaped groves consisting of 18 wattles spaced 3 m apart with a slower growing flowering gum (*Corymbia ficifolia*) in the centre. In total there are six wattle groves planted on the range situated approximately 40 – 60 m from the shed. Hens were observed utilising the groves for dustbathing, sheltering and resting (Figure 6). Tree roots remain well protected from hen activities, with large rocks placed at the base of the young trees (Figure 5). In total the farm has over a 1,000 newly planted trees. On other range areas, trees have recently been planted in twin rows that start near the shed and extend to the outer range to help encourage hens to move further out from the shed.

Practices used to manage the range vegetation (e.g. rotation time between different areas of the range, frequency of mowing); Some range areas on the farm require regular mowing (fortnightly) due to underutilised sections on the range and the fast growth of grasses such as cocksfoot (*Dactylis glomerata*), perennial ryegrass and prairie grass (*Bromus willdenowie*). There is also a background of subclover (*Trifolium subterraneum*). The farm was an ex-dairy property and the grasses and the subclover are the result of what was a well maintained dairy pasture. Nevertheless, grass dominant ranges have been oversown with pasture legumes such as lucerne, red and white clover.

Figure 4: Farm 2 plant nursery used to grow trees to a larger size before planting on the range.





Figure 5: Farm 2 wattle planted (1 year since planting) on the range with rocks around the base to protect the roots.



Figure 6: Wattle groves with trees at least 3 m tall after only 2 years since planting on the range of farm 2, groves are being highly utilised by hens.

Farm 3 – Sub tropical (summer dominant rainfall) climatic zone

The information presented on farm 3 is based on two visits with no specific flocks followed. Three systems of free range production are being run on the farm; fixed range 1,500 hens/ha, fixed range 10,000 hens/ha and organic mobile sheds at 1,500 hens/ha.

Average Annual Rainfall & Rainfall pattern; regional rainfall average = 626 mm, summer dominant pattern.

Rainfall total for 2018 = 544 mm.

Rainfall total for 2019 = 169 mm.

Soil type; Clay and heavy loams. Average soil pH in the surface layer is 6.2 (0 – 10 cm) and increases in alkalinity with depth; 7.1 (0 – 30 cm) and 8.8 (50 – 60 cm).

Length of time the farm has been operating; at least 10 years

Range size, range shape, locality of the shed within the range area; Organic production - Rectangular shaped range with the shed in the middle, each range is 3 ha (1.5 ha each side of the shed). Another range area the same size is adjacent, this is used in rotation every 60 weeks. The organic shed is designed to be moved to the adjacent location with every new flock.

Orientation of shed; East-West

Shed type (1-sided or 2-sided pop-holes); 2 sided with pop holes on southern and northern sides.

Additional structures (e.g. shade shelters, hay bales) on the range; long rectangular shade shelters are placed near pop holes (8 – 12 shelters per shed)

Flock size and flock age; Hy-line Brown and Isa Brown, organic flock = 4,500 hens.

Outdoor stocking density; Organic flock = 1,500 hens/ha.

Percentage of total flock on the range, where on the range and what is the main activity of the hens, weather conditions at time of visit; Not assessed on the first visit in 2018. On the day of the second visit in November 2019, it was hot and sunny day with a maximum temperature 36°C. Some hens in all free-range systems had left the shed but did not venture far onto the range and remained close to the popholes or sheltered under the ramps and shade shelters adjacent to the sheds.

Plumage condition score and beak shape scores of hens on the range and indoors; Not assessed.

Ground cover plant species including weed species on the range; The main perennial grasses growing on the ranges are Rhodes grass (*Chloris gayana*), Creeping blue grass (*Bothriochloa insculpta*), African lovegrass (*Eragrostis curvula*), African star grass (*Cynodon plectostachyus*) and unimproved native grass pastures. Lucerne had also been sown on some of the ranges. Kikuyu (*Pennisetum clandestinum*) had been trialled in the past but was too reliant on irrigation to keep it looking good and growing. Mostly Rhodes grass is resilient to hens (Figure 7), but it can be killed by hens if they are allowed too soon onto new regrowth following mowing. Although another species of Rhodes grass, "Feathertop Rhodes grass" (*Chloris virgata*) has become an issue on some 1,500 hen/ha ranges. It is considered a major weed of broad acre farming enterprises and is a tufted annual that grows to 1 m tall that can readily set and reproduce from seed and competes strongly with more desirable species.

Condition of the ground cover vegetation on the range;

2018 - Despite most ranges being well covered (except closest to the shed) most flocks don't venture much further than 20 – 30 m from the shed. It was noted by the farm manager the hens do not like moving through tall grass. To encourage hens out, corridors were mown through long grass however this still had minimal effect on encouraging more hens further out.

2019 – Drought conditions have impacted pasture growth severely whereby there had been no new growth at the time of the visit in November 2019. Ranges stocked at 1,500 hens/ha had maintained standing dry grass further away from sheds.

Tree type, location on the range, number and age of trees;

Trees and shrubs are locally adapted. Wattles are not being planted because of potential weediness concerns as the farm is located close to native bushland. Newly planted trees on the range are protected with wire mesh guards, not to prevent hen damage but to protect against corellas that nip out growing tips and strip the leaves from young trees. Mulch pads are also used around the base of newly planted trees. They reduce weeds, are designed to funnel light rain and dew onto the root zone and reduce evaporation from the root zone (Figure 9). Recent tree plantings have been arranged in rows radiating out from the shed onto the range, it's anticipated that this will encourage more hens further away from the shed.

Oldman saltbush (*Atriplex nummularia*) variety "De Kock" had been planted during 2019 on the ranges of the 10,000 hens/ha sheds and some organic sheds ranges. The saltbush area is fenced off from hens on the 10,000 hens/ha sheds while the saltbush establishes (Figure 10). When the saltbush reaches at least 1 m tall the area will be opened up for hens to access. The area planted to saltbush starts 5 m from shed out to the first row of trees approximately 30 m away in a 3 x 3 m configuration. It is the zone on the range that normally doesn't grow much. Saltbush is doing very well with the tallest saltbushes already 40 – 50 cm high after 4 months post planting. Those saltbushes closest to the tree line are shorter due to competition effects from trees. In addition, saltbush is responding very well to fertiliser, particularly nitrogen. The saltbush on the organic shed ranges were planted in twin rows inside the range boundaries and also at right angles from the shed to the outer saltbush boundary. Planting rows were firstly deep ripped, then a planting hole was made with an auger. Fertiliser was also added to the planting hole. Under the dry weather conditions of 2019 the saltbush was watered weekly.

Practices used to manage the range vegetation (e.g. rotation time between different areas of the range, frequency of mowing);

Organic system rotates the range area every 60 weeks.

Usually fixed range areas of 1,500hens /ha require regular mowing of the outer range areas (Figure 8), except during 2019 as there was very little growth due to dry conditions.

Fixed range 10,000 hens/ha range areas usually require re-sowing. However, free range accreditation schemes stipulate that only one-third the area at any one time can be fenced off and re-sown. In light of this, the farm may consider placing a 10,000 hens/ha flock under barn production for one production cycle to allow the pasture on the range to be totally renovated.



Figure 7: Farm 3 Rhodes grass clumps on a range stocked at 10,000 hens/ha.



Figure 8: Farm 3 naturalised perennial grasses and young trees (planted) on the range stocked at 1,500 hens/ha



Figure 9: Fluted mulch pad that collects rain and dew and redirects water to root zone.



Figure 10: Farm 3 saltbush planted in the 5 to 30 m zone of a 10,000 bird/ha shed. Growth at 3 months old.

Farm 4 – Temperate (no dry season with a warm summer) climatic zone

Average Annual Rainfall & Rainfall pattern; 1066 mm, uniform rainfall pattern.

Rainfall total for 2019 = 617 mm.

Soil type; Heavy textured clay soils. Soil pH measured in CaCl₂ is highly acidic through much of the profile, 3.0 – 4.8 (0 – 60 cm) and 5.6 – 6.0 (60 – 100 cm).

Length of time the farm has been operating; The farm has been running poultry since 1997 and the case study shed is 7 years old.

Range size, range shape, locality of the shed within the range area; the shape of the range is roughly square and subdivided into 4 paddocks. Each subdivided paddock is one hectare.

Orientation of shed; East-West

Shed type (1-sided or 2-sided pop-holes); 2 sided with pop holes on southern and northern sides.

Additional structures (e.g. shade shelters, hay bales) on the range; No shade structures on the 10,000 hen/ha range as there are plenty of trees.

Flock size and flock age; 30,000 Hy-Line Brown, 40 weeks old at the time of the visit (July 2019).

Outdoor stocking density; 10,000 hens/ha.

Percentage of total flock on the range, where on the range and what is the main activity of the hens, weather conditions at time of visit; Approximately 4,000 birds outside. An estimated 300 hens were foraging on the outer extremities of the range area with the majority of the hens dustbathing under trees by the shed. The weather was sunny, 14 – 17°C, light breeze, slightly damp soil.

Plumage condition score and beak shape scores of hens on the range and indoors; Feather condition was not scored on the visit, but the feather condition of those birds seen outside was very good. There was no neck damage, back or tail damage and plumage was smooth.

Ground cover plant species including weed species on the range; Blue couch (Kentucky bluegrass) was doing well (Figure 12). This was harvested from other parts on the farm and transplanted on the range area. Initially the couch runners needed to be buried to protect from hens. Sowing Kentucky bluegrass seed was considered but seed is extremely expensive at \$300/kg. Turf type grasses can be useful for the range but expensive seed will be an issue on large range areas. Therefore farm management are considering buying a second-hand turf harvester for transplanting their own couch. Pin rush (*Juncus usitatus*) is growing in some places with couch in between (Figure 11), however pin rush can be destroyed by hens, they can trample through and flatten it to the ground. Kikuyu is growing in some areas on the range, however hens will eventually dig up the runners. Kikuyu is an issue on the farm, as the property also raises cattle. Nitrite poisoning and a fungal disease that infects kikuyu can cause toxicity in cattle.

Perennial ryegrass and red clover have been sown on some of the ranges. Although the clover is the first to be picked out by the hens. Lucerne has also been trialled but was not successful.

Common weed species on the range are stinging nettle (*Urtica dioica*), marshmallow (*Malva parviflora*), fat hen (*Chenopodium album*), Paddy's Lucerne (*Sida rhombifolia*). The hens do not eat

the stinging nettle and they use the Paddy's Lucerne for shelter. Weed control is via mulching, especially weeds such as marshmallow.

Tree type, location on the range, number and age of trees;

At least 10 native tree species which include sheoaks and callistemon were planted 8 years ago. Wattles were originally planted on the range but these were removed due to processionary caterpillars (*Ochrogaster lunifer*) that lived on the wattles. Processionary caterpillars were a major problem due to their noxious hairs that irritated livestock including the hens.

The closest group of trees are located 10 – 20m from the shed. Some trees have their roots exposed from hen activity, particularly those growing on steep slope areas. Some trees closest to the shed are dying and this may be due to high nutrient loads. Trees have also been planted on the downside of contour banks.

Practices used to manage the range vegetation (e.g. rotation time between different areas of the range, frequency of mowing);

The subdivision of the range into 4 areas enables rotation with one area re-sown and rested at a time. The area requiring renovation is firstly cultivated to level out the surface from dust bathing divots. The overall range is sloping with contour banks. The contour banks have been fenced off from hens. Connecting passageways have been constructed through contour banks to enable hens to move to the lower slope areas of the range. These passage areas have tyres and mesh to protect soil from digging birds and allow water movement.



Figure 11. Couch grass area with pin rush and trees below contour bank.



Figure 12. Couch grass on the lower slope of case study farm 4.