The utilisation of low-fibre sunflower residue in the diet of hybrid and village chickens raised in pens and on free-range[1]

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Abstract

Low-fibre sunflower residue (SFR) included in the diet is a viable option for improving production in smallholder-owned poultry. Four hundred day-old broiler chicks (200 hybrid + 200 village chicks) were given broiler starter (1-28 days) and a low-fibre sunflower residue diet (29-84 days). On day 29 the chicks were randomly allocated to four treatments (2 types of chicks, 2 systems of housing): Hybrid, in pen and free range; Village in pens and free range; replicated on 10 farms and managed by women. Weight gain, feed and water intake were significantly lower (P<0.05) in village chickens (0.70–0.72 kg) at eight weeks and (1.05 kg–1.19 kg) at 12 weeks compared with hybrid chickens (1.96–2.43 kg) at eight weeks and (2. 54–3.37 kg) at 12 weeks. However, the breast meat tissue of the village chickens was high in crude protein (CP, 74 per cent) and low in ether extract (EE, 33 per cent) compared with 69 per cent CP and 50 per cent EE in hybrids. At eight weeks, feed efficiency in free-range village chickens (2.7) was similar to hybrids in pen (2.6) and free-range hybrids. This was better than village chickens in pen (3.2). Interestingly, at 12 weeks, feed efficiency declined in hybrids (4.0 penned, 4.2 free-range), while there was an improvement in village chickens (3.0 penned, 2.6 free-range). A low water: feed ratio was observed in village chickens (1.6 free-range, 1.7 penned) compared with free-range hybrids (2.1) and hybrids in pen (2.2) at eight weeks. However, at 12 weeks the differences in water: feed ratio between hybrid and village chickens were not significant (P>0.05), being 2.2 in pen and 2.1 in free-range hybrid compared with 1.9 in penned and 1.8 in free-range village chickens. At eight weeks the gross margin per bird for hybrids (equivalent to US$ 2.30-3.19) was high compared to village chickens (equivalent to US$ 54-0.79). But at 12 weeks village chickens showed improved gross margin (equivalent to US$ 1.21-1.27) compared with hybrid chickens (equivalent to US$ 1.27-2.33). Return per dollar of village chickens in pens (1.30) was lower than village chickens on free-range (1.55), which was similar to hybrid chickens on free range (1.60). At 12 weeks, return per dollar significantly improved (1.48–1.61) for village chickens compared with 1.20–1.30 for hybrid chickens.

Key words: low-fibre SFR, village chicken, hybrid chicken, free-range, value added, feed efficiency

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Introduction

The availability of feed, both quantity and quality, at affordable cost is a major factor limiting poultry production in Zimbabwe and as a result, the demand for low-cost feed is high. Sunflower (*Helianthus annus*), is a potential source of protein for inclusion in poultry diets. It is high in fibre, rich in sulphur-containing amino acids, cystine and methionine but low in lysine. The high fibre content limits the utilisation of the sunflower residue in poultry (Smith, 1968). The presence of high fibre and associated polyphenolic compounds (chlorogenic acid), in sunflower hulls limit intake and digestibility and may cause adverse effects on poultry performance (Singleton and Kratzer, 1969). Mupeta, *et al.* (2001), demonstrated a sieving technique, consisting of passing sunflower residue through 1.4 mm screen and produced low-fibre sunflower residue, which could improve the utilisation of sunflower residue and, thus, poultry performance. There is a double benefit in reducing the fibre fraction since chlorogenic acid is found in association with the sunflower seed hull (Luhaloo, 1996).

Approximately 80 per cent of poultry in Africa are raised in rural areas where they contribute substantially to meat and egg production (Sonaiya, 1997). In Zimbabwe, about 50 per cent of the birds from the commercial poultry breeders are marketed in the rural areas, where they are generally raised on a free-range system, surviving as scavengers.

The potential of low-fibre sunflower residue for inclusion in poultry diets and the performance of hybrid and village chickens raised in pens and on free-range has not been evaluated on-farm. Therefore, the objective of the present study is to evaluate the utilisation of low-fibre sunflower residue included in poultry diets on the performance of hybrid and village chickens, raised in pens and on free-range under participatory management by women farmers at household level.

Materials and methods

Three hundred and fifty eggs (1-7 day-old) were collected from village chickens. The eggs, weighing 23 ± 1.6 g, were kept at room temperature for 24 hours and then transferred to an incubator. At the 18th day of incubation the eggs were transferred to hatching trays. Hatching started during the 18th hour of the 21st day of incubation. Two hundred and thirty chicks were hatched by the 23rd day of incubation (66 per cent hatchability). The 23rd day coincided with the arrival of 228 day-old hybrid chicks.

Two hundred hybrid chicks (42 ± 2 g) and 200 village chicks (38 ± 1.5 g) were divided into 16 groups of 25 chicks and transferred to 16 brooder boxes and reared for 28 days. The brooder boxes, measuring 6 m^2 with mesh floors and raised 20 centimetres above ground were housed in a thatched house. Natural light was used in the daytime, with no supplementary lighting at night during brooding. On day 29, the chicks were randomly grouped into 40 groups of 10 birds and allocated to four treatments, which were replicated at 10 households, and managed by women. The treatments included: hybrid chicks in pens; hybrid chicks on free range; village chicks in pens; and village chicks on free range. (Free-range is defined as scavenging for food; village chicken are indigenous chicken). Broiler starter feed and water were offered *ad libitum* to both hybrid and village chicks during this period.

The low-fibre sunflower residue diet was offered *ad libitum* to hybrid and village chickens raised in pens (29-84 days), while those on free-range received 75 per cent of the weekly intake of SFR diet of chickens in pens. The finisher diet consisted of low-fibre sunflower residue (SFR), broiler concentrate and maize meal, in the ratio 1.36: 1: 2.18, respectively. About 2,500 kg of sunflower seed was compressed using a ram press and yielded 600 kg of oil and 1,800 kg of sunflower residue. The sunflower residue was passed through a sieve with a 1.4 mm screen to recover a low-fibre, high protein fraction and retain a high fibre, low protein fraction. The low-fibre sunflower residue was used as a protein source in the poultry diet. The maize meal was a product of white maize grain, milled to pass through a 1.0 mm screen using a hammer mill. All feed was mixed in bulk to ensure uniformity. Mixing was done on a concrete floor using shovels, after which the feed was distributed to the participating farmers. Tubular metal hoppers, 40 cm in diameter, carrying 10 kg of feed were used as feeders. Round plastic basins, 15 cm deep and 25 cm diameter wide, were filled with clean water each morning. Feed troughs were cleaned and filled with feed once a week, while the birds were being weighed.

Measurements

Chickens were weighed weekly, on the same day and time, using a hanging balance scale. Daily feed intake was recorded as the difference of feed offered and feed remaining in the feed hopper, and daily water intake as the difference of water offered and water left. Daily temperatures were recorded in the morning at 0600 h, at noon and evening at 1800 h. Two chickens from each of the treatments were slaughtered at eight and 12 weeks to measure dressing percentage, lean, bone, and protein and fat value of meat. Profitability was calculated using prevailing variable input costs and the revenue from sale of chickens at eight and 12 weeks

Chemical analysis

Samples of the experimental diets were analysed according to the methods of the Association of Official Analytical Chemists (1990), Table 1). Analysis was conducted for dry matter (DM), crude protein (CP; N x 6.25), crude fibre (CF), ether extract (EE), calcium and phosphorus. Metabolisable energy (ME) contents of the diets were calculated from the chemical analysis data using pre-established formulae (Wiseman *et al.* 1991):

$$ME\ (kcal/kg) = 4.26X_1 + 9.5X_2 + 4.23X_3 + 4.23X_4$$

The calculated digestible crude protein, fat, fibre and nitrogen free extractives (g/kg feed) are represented by X_1 through X_4 respectively.

Statistical analysis

Data on various parameters of broiler performance were subjected to statistical analysis using analysis of variance (ANOVA); General Linear Model procedure of GENSTAT 5 Release3.2 statistical software.

Results

Feed

Table 1 shows the chemical composition of the local feed ingredients, commercial starter and SFR diets. Compared with the original sunflower residue, the low-fibre SFR fraction contained 28 per cent less fibre and 14 per cent more protein. There were no differences

in the content of oil (EE), ME (MJ/kg), minerals (Ca and P) and amino acids (methionine and lysine). Protein content of the SFR diet (196 g/kg DM) was within the recommended level of 180 g/kg DM for the finishing phase (29-56 days; NRC, 1977). The SFR diet was high in fibre (70 g/kg DM) and oil (120 g/kg DM) compared to levels of 50 g/kg DM fibre and 30 g/kg DM fat, formulated by Agrifoods (Pvt) Ltd, a commercial feed manufacturing company in Zimbabwe.

Table 1 *Chemical composition (g/kg DM) of feed ingredients and experimental diets fed to village and hybrid chickens raised in pens and on free-range*

Feed Ingredient	Feed Ingredient. (%)	CP*	CF	EE	Ca	P	ME Mj/kg)	Methionine	Lysine
Sunflower residue (SFR)		203	202	326	2	10	11.3	8.1	7.2
Diet Ingredients									
Sieved SFR fraction	30	231	145	322	2	10	11.6	8.3	7.3
Maize meal	48	80	36	40	0.2	2.5	14.2	3.6	2.7
Broiler concentrate	22	390	42	29	7.5	9	10.4	14	30
Experimental diets									
Low-fibre SFR	100	196	69	121	6.1	8.7	12.4	0.76	1.04
Commercial starter	100	224	30	28	9.4	8.8	12.3	0.69	1.16

*CP = crude protein; CF = crude fibre; EE = ether extract; ME = metabolisable energy

Table 2 revealed that hybrid chickens in general consumed 64 per cent more feed at eight weeks and 65 per cent at 12 weeks than village chickens ($P<0.001$). At eight and 12 weeks hybrid chickens raised in pens consumed 25 per cent more feed than those raised on free-range, while village chickens in pen consumed 23 per cent more feed at eight weeks and 34 per cent more at 12 weeks than those on free-range ($P < 0.05$).

Table 2 *Performance of hybrid and village chickens fed a low-fibre sunflower residue (SFR) diet, raised in pens and free-range up to 8 and 12 weeks of age*

Up to 8 weeks of age

	Hybrid chickens		Village chickens			
Parameters	Pen	Free-range	Pen	Free-range	s.e.m	Sig*
Live weight (kg/bird)	2.43[a]	1.96[b]	0.72[c]	0.70[c]	7.760	***
Feed consumption (kg/bird)	6.31[a]	5.28[b]	2.32[c]	1.9[d]	1.768	***
Feed efficiency ratio	2.6[a]	2.7[a]	3.2[b]	2.7[a]	1.64	*
Water consumption (litres/bird)	13.70[a]	10.91[b]	4.0[c]	3.43[d]	2.609	***
Water: Feed ratio	2.2[a]	2.1[a]	1.7[b]	1.6[b]	0.25	*

Up to 12 weeks of age

	Hybrid chickens		Village chickens			
Parameters	Pen	Free-range	Pen	Free-range	s.e.m	Sig
Live weight (kg/bird)	3.37[a]	2.54[b]	1.19[c]	1.05[c]	0.833	***
Feed consumption (kg/bird)	13.48[a]	10.66[b]	3.56[c]	2.88[d]	1.925	***
Feed efficiency ratio	4.0[a]	4.2[a]	3.0[b]	2.6[c]	1.05	*
Water consumption litres/bird	29.41[a]	20.85[b]	6.88[c]	5.18[d]	6.573	***
Water: Feed ratio	2.2[a]	2.0[a]	1.9[a]	1.8[a]	0.25	NS

*NS, $P>0.05$; * $P<0.05$; ***$P<0.001$

[abcd] Values with different superscripts in the same row are significantly different.

FER Feed intake: live weight gain ratio

Water: Feed ratio = Relationship between water consumption to feed intake

Water

Hybrid chickens consumed more water than village chickens ($P<0.01$), the increase being 70 per cent and 76 per cent at eight and 12 weeks, respectively (Table 2). The water: feed ratio was significantly high ($P<0.05$) in hybrid chickens compared with village chickens at eight weeks. However, at 12 weeks, there were no significant differences in the water to feed ratio between village and hybrid chickens. The difference in daily water consumption at 12 weeks was higher in hybrids than village chickens ($P<0.05$). At eight

weeks the difference between village chickens in pens and on free range was 29 per cent, while it was 20 per cent between hybrid chickens.

Live weight

Weight gain of village chickens in pens and on free–range was low compared with the hybrid chickens ($P<0.001$) (Table 2). While hybrid chickens in pens were significantly heavier (25 per cent) than those on free-range ($P<0.05$), the differences between village chickens in pens and those on the free-range was small, 3 and 11 per cent) at eight and 12 weeks respectively ($P>0.05$). At eight weeks, feed efficiency (FER) in free-range village chickens was similar to that of hybrids in pen and hybrids on free-range. This was significantly more efficient than in village chickens in pens. However, at 12 weeks FER in hybrid chickens decreased for hybrids in pens and hybrids on the free-range, while the FER in village chickens improved in pens and on the free-range.

Carcass quality

Carcass characteristics of hybrid and village chickens are given in Table 3. Both, plucked dead weight and dressing percentage were high ($P<0.05$) in hybrid chickens compared with village chickens at eight weeks. However, at 12 weeks the difference in dressing percentage was small and not significant ($P>0.05$). The meat to bone ratio was high ($P<0.05$) in hybrid chickens compared with village chickens. Meat yield at eight weeks was less in village chickens due to differences in the shape of their growth curves. Village chickens significantly ($P>0.05$) accumulated more protein in the breast meat tissue, while hybrid chickens consistently accumulated more fat.

Management effect

Table 4 shows the effects of the farmer (management) on the performance of chickens raised in pens and on the free-range, given the low-fibre sunflower residue diet. There were significant differences ($P<0.05$) in mortality between some of the farms. Farm 4 experienced the highest mortality (per cent) followed by Farm 3 and Farm 9, while Farms 1, 5, 6 and 7 recorded zero mortality. Significant differences in live weight were observed during week 5, with farms 4 and 3 producing lighter chickens, while Farms 7, 6, 1 and 2 showed better performance in water and feed consumption.

Table 3 *Carcass characteristics (kg) and nutrient composition (g/kg DM) of lean in hybrid and village chicken raised either in pens or on free-range*

	Hybrid chickens		Village chickens		
At 8 weeks	Pens	Free-range	Pens	Free-range	s.e.m
Plucked dead weight[1]	1.85	1.48	0.67	0.66	0.566
Dressing[2] %	72.9	73.6	60.0	59.8	1.23
Bone	0.25	0.20	0.10	0.10	0.023
Lean	1.10	0.88	0.30	0.29	0.057
Dry matter (DM, g/kg)	975	976	978	977	12.5
Crude protein	692	695	743	739	29.1
Ether extract	491	476	338	334	38.8
Ash	74	69	101	99	19.8
At 12 weeks					
Plucked dead weight	2.58	1.86	1.11	1.00	0.613
Dressing %	66.0	68.6	65.3	65.0	2.51
Bone	0.31	0.23	0.18	0.16	0.031
Lean	1.40	1.05	0.54	0.49	0.059
DM (g/kg)	974	975	973	974	12.3
Crude protein	689	691	745	742	29.3
Ether extract	514	511	340	338	42.4
Ash	83	86	103	102	23.1

[1] Plucked dead weight = live weight of bird less the weight of feathers

[2] Dressing % = percentage of carcass weight (live weight less feathers and offal) (offal = head, heart, lungs, liver, intestine, feet)

Table 4 *Effect of farm (management) estimated by performance of hybrid and village chicken*

Live weight (kg/bird/wk)	**Farm number**											
	1	2	3	4	5	6	7	8	9	10	s.e.m	***Pr >F***
4 weeks	0.37	0.36	0.36	0.34	0.36	0.36	0.36	0.35	0.36	0.36	0.010	***0.469***
5 weeks	0.64	0.69	0.51	0.41	0.67	0.59	0.69	0.56	0.63	0.64	0.083	***0.050***
8 weeks	1.55	1.53	1.43	1.28	1.42	1.52	1.64	1.57	1.51	150	0.098	***0.295***
12 weeks	2.14	2.10	1.93	1.70	2.04	2.18	2.11	2.06	2.11	2.05	0.118	***0.070***
Feed intake (kg/bird/wk	**Farm number**											
	1	2	3	4	5	6	7	8	9	10	s.e.m	***Pr >F***
5 weeks	0.75	0.78	0.51	0.54	0.58	0.49	0.52	0.38	0.50	0.50	0.074	***0.016***
8 weeks	1.00	1.00	1.01	0.84	0.97	1.01	0.98	0.91	0.96	0.97	0.037	***0.05***
12 weeks	1.17	1.16	1.21	1.09	1.17	1.18	1.19	1.10	1.17	1.16	0.036	***0.597***
Water intake (litres/bird/day)	Farm number											
	1	2	3	4	5	6	7	8	9	10	s.e.m	***Pr >F***
5 weeks	0.18	0.26	0.25	0.22	0.23	0.25	0.25	0.20	0.23	0.24	0.067	***0.001***
8 weeks	0.35	0.38	0.28	0.36	0.34	0.37	0.37	0.41	0.37	0.37	0.021	***0.021***
12 weeks	0.54	0.40	0.34	0.41	0.40	0.31	0.41	0.45	0.37	0.36	0.037	***0.001***
Mortality (%)	0.0	2.5[a]	7.5[a]	10.0[a]	0.0	0.0	0.0	2.5[a]	5.0[c]	2.5[a]	0.113	***0.041***

Profitability

The profitability of feeding a low-fibre SFR diet to hybrid and village chickens raised in pens and on free-range is given in Table 5. Hybrid chickens showed a higher gross margin at eight and 12 weeks ($P<0.001$) compared with village chickens. But, at 12 weeks, the return per dollar was better in village chickens compared with the hybrid chickens ($P<0.01$). At eight weeks return per dollar was low in village chickens in pens and high for hybrid chickens in pens, while no difference was observed between village and hybrid chickens on free-range. Within hybrid chickens, gross margin and return per dollar were lower on free-range than in pens. In contrast, village chickens on free-range showed higher gross margins and return per dollar ($P<0.05$) than village chickens in

pens. At 12 weeks compared with eight weeks, the gross margin in hybrid chickens declined, while an increase was observed in village chickens.

Table 5 *Profitability of feeding low-fibre sunflower residue (SFR) to hybrid and village chickens raised in pens and on the free-range at eight and 12 weeks of age*

	Gross Income* (US$ equivalent/bird)	TVC** (US$ equivalent/ bird)	GM*** (US$ equivalent/ bird)	Return per $ Invested****
At 8 weeks of age				
Hybrid birds in pens	7.27[a]	4.08 [a]	3.19 [a]	1.80 [a]
Hybrid birds free-range	5.87[b]	3.57[b]	2.30 [b]	1.60 [b]
Village birds in pens	2.29[c]	1.75 [c]	0.54 [c]	1.30 [c]
Village birds free-range	2.23[c]	1.43 [d]	0.79 [d]	1.55 [b]
CV %	38.3	50.9	32.2	15.5
Pr > F	*0.001*	*0.016*	*0.001*	*0.001*
At 12 weeks of age				
Hybrid birds in pens	10.11 [a]	7.78 [a]	2.32 [a]	1.30 [a]
Hybrid birds free-range	7.61 [b]	6.35[b]	1.27[b]	1.2[a]
Village birds in pens	3.76[c]	2.54[c]	1.21[c]	1.48[b]
Village birds free-range	3.33[d]	2.07[d]	1.27[c]	1.61[b]
CV %	10.2	9.3	46.5	9.2
Pr > F	*0.001*	*0.001*	*0.001*	*0.046*

[Abc] Means in the same column with different superscripts differ significantly ($P<0.005$)

*Gross Income = X*Y

[***]GM = Gross Margin = (X*Y) – (TVC)

[****]Return per dollar invested = Gross Income/ TVC)

X = Live weight of chickens (kg)

Y = Price of chickens $/kg ($900 and $950 hybrid and village birds respectively)

[**]TVC = Total variable costs (Costs directly related to production e.g. feed, water, labour)

CV Co efficient of variation

Discussion

In the present study, the low-fibre SFR diet was given to hybrid and village chickens raised in pens or on free-range, and managed by 10 women at their homesteads in Zimbabwe. The low-fibre diet was achieved by passing SFR through a 1.4 mm screen to recover the low-fibre, high protein fraction for inclusion in poultry diets. Reduction in fibre content was important, since fibre causes negative utilisation of energy. The corresponding reduction of chlorogenic acid, a phenolic compound associated with sunflower hulls is also important since it is known to interact with the amino group of lysine and thus decrease its availability (Sen and Bhattacharyya, 2000).

Live weight

Indigenous chickens are genetically slow growing and tend to have a low mature body weight at the same age as hybrid chickens. This was demonstrated in the current study where hybrid chickens were heavier in pens and on free-range than village chickens in pens and free-range. However, these weights were higher when compared to village chickens and hybrids when a standard commercial diet was given (Mupeta *et al.*, 2002).

At eight–12 weeks, hybrid chickens in pen were 19 per cent heavier than hybrid chickens on free-range ($P<0.05$), while village chickens in pen and those on the free-range showed a small difference of 3 per cent ($P>0.05$). The small difference could be linked to the natural instinct and ability of village chickens to scavenge under free-range. Village chickens raised on free range showed a high content of insects in their crops after slaughter, including grasshoppers, earthworms and fly larvae, while the crops of the hybrid chickens contained mainly the SFR diet. These insects are rich in protein ranging from 42 per cent CP in fly larvae, 60 per cent CP in earthworm to 76 per cent CP in grasshoppers (Newton *et al.,* 1977; Gohl, 1981; Sugimura *et al.*, 1984). Gohl, (1981) showed that the amino acid content of protein from insects was similar to that of fishmeal, an exceptionally good source of high quality protein. The better performance in village chickens on free range is supported by a good FER at 12 weeks compared with hybrid and village chicken in pens. These findings agree with Ayorinde (1991), who reported poor feed conversion when local fowl in Nigeria were kept intensively. The FER of hybrid chickens decreased in weeks eight-12 by approximately 54 per cent, while that of village chickens increased by 1.8 per cent with chickens on free-range being more efficient (Table 2). The above argument is supported by the difference in daily feed intake between village chickens on free-range and those in pens of 23 per cent at eight weeks and 34 per cent at 12 weeks respectively. It may be speculated that at 12 weeks, village chickens on free-range were substituting the concentrate diet for scavenged feedstuffs. It is reasonable to assume that being summer, the chickens were eating more insects as illustrated by the contents of the crops of slaughtered chickens. Thus, it may be suggested that compared with hybrid and village chickens at eight weeks, village chickens utilise feed more efficiently at 12 weeks when they are allowed to scavenge on free-range but given a concentrate diet as a supplement. However, the disadvantage of free-range is the fluctuation in the nutritive value and variability of feedstuffs, which may be influenced by the seasonal pattern. The high performance of hybrid chickens observed in the current study is in accord with the standard practice of marketing hybrid chickens at eight weeks, when efficiency of feed utilisation is high. Beyond eight weeks, profit is diminished due to inefficient feed utilisation. On the other hand it may still be profitable to keep village chickens beyond 12 weeks due to the improved feed utilisation efficiency. The slow growth in village chickens may be viewed as an advantage, as it

ensures a regular supply of fresh meat to the household over a longer period. However, the subject is beyond the scope of the present study.

Carcass characteristics

The mean dressing percentage in village chickens was low at eight weeks compared with hybrid chickens. But the difference tended to diminish at 12 weeks, in penned and free-range hybrids compared to village chickens in similar treatments. This confirms previous findings (Mupeta *et al.,* 2002) that up to eight weeks of age, offal (digestive tract, feet, head and neck) in relation to carcass, grow at a higher rate ($P<0.05$) in village chickens compared with hybrid chickens. The carcass yield in village chickens was lower ($P<0.05$) compared with hybrid chickens at 12 weeks and at eight weeks. However, the quality of breast meat tissue of village chicken appeared more favourable in terms of high protein and less fat compared with fat in hybrid chickens. The high protein in village chicken breast meat tissue is likely to be due to the increased muscle development required for scavenging and, at times, flight (Ayorinde, 1991). Similarly, the low percentage of body fat may be a consequence of the arboreal or feral mode of living. High dietary fat intake is linked to incidences of cardiovascular disease and cancer and high body fat deposition is associated with inefficient energy metabolism, representing an economic loss to the producer (Pasternak and Shaley, 1983).

Water consumption

Many factors are known to affect water intake: genetic, dietary salt concentration, source and concentration of dietary protein and physical form of the diets (Marks, 1979). In the present study, hybrid birds in general consumed 74 per cent more water than village chickens, with hybrids in pen consuming 26 per cent more water than those on free-range, while village chickens in pen consumed 21 per cent more water than those on free-range. Water intake was related to feed consumption. Although hybrid birds consumed more feed and more water, no significant differences in water: feed ratios were found at 12 weeks between hybrid and village chickens. However, at eight weeks, the water: feed ratio was significantly lower in village chickens compared to hybrid chickens. The reliability of the empirical rule suggests that a bird will drink twice the weight of its feed intake (NRC, 1977). This concurs with the present study, where, at 12 weeks the water: feed ratio ranged from 1.8 to 2.2 in hybrid and village chickens, respectively. Gardiner and Hunt (1984) reported a water: feed ratio of 1.75 in the ninth week of feeding in meat–type chickens and showed a positive correlation coefficient ($r^2 = 0.97$) between water and feed intake. Water intake is more dependent on the availability of feed than feed is on the availability of water (Marks and Brody, 1984). It may be speculated that the observed difference between village chickens could be due to water economy, a survival mechanism developed by village chickens on free-range.

The ability to estimate the amount of water consumption of growing chicks is important because water supply is a limiting resource among most of the smallholder farming areas especially those located in the marginal agroecological regions of Zimbabwe.

Management effect

Live weight, feed intake, water intake and mortality were used as indicators of management ability between farms. The effects of the different treatments for each of the indicators were pooled together in order to facilitate comparisons. There were significant differences in management related to mortality, feeding and watering the chickens. However, difference in management only approached significance at five and

12 weeks. Week five coincided with a change of diet from commercial starter to the low-fibre SFR diet. Farm four experienced the highest mortality and consistently showed low management for all parameters. Farms one, five, six and seven experienced zero mortality and appeared to apply reasonable management practices. Successful poultry management requires the application of factors including skills, labour, feed and water management, record keeping, aptitude, hygiene and health. Patullo (1987) reported output between farms to be influenced by differences in farmer's working knowledge of animal nutrition, disease and aptitude. Aptitude may be expressed as the ability of the farmer to decide on certain critical operations in order to take corrective measures before major problems arise. All the farmers kept records as a requirement to participate in the study, but the use of these records as a reference tool for budgeting and planning tended to vary with farm.

Profitability

Gross margin analysis and return per dollar invested were employed to evaluate the profitability of feeding a low-fibre SFR diet. Gross margins in village chickens increased with age, being higher at 12 weeks than eight weeks, while gross margins in hybrids decreased. At 12 weeks, return per dollar from village chickens was significantly higher ($P<0.05$) compared with hybrid chickens. Up to eight weeks, it was more profitable to feed hybrid chickens ($P<0.001$) as both gross margins and returns per dollar were significantly higher compared with village chickens. Previous experiments showed similar results of hybrids out-performing village chickens under improved management when a commercial diet was fed (Mupeta *et al.,* 2002). Village chickens on free-range, but supplemented with a low-fibre SFR diet showed superior gross margins and returns per dollar compared with village chickens raised in pens. These results show that low-fibre SFR may be a viable option in poultry diets to feed both hybrid and village chickens in pens or as supplements on free-range.

Conclusion

Low–fibre sunflower residue included in the diet is a viable option for improving production in smallholder–owned poultry. No adverse effects on performance, from feeding sunflower seed residue were observed. Hybrid chickens reared on free-range showed limited scavenging ability. Village chickens are poorer feed converters in pens than on free-range. However, the performance of village chickens improved with age, with improved feed efficiency, gross margin and return per dollar at 12 weeks compared to eight weeks. The meat of village chicken contains more protein and less fat than hybrids, indicating possible market advantages for village chickens.

References

AOAC. (1990). Official *Methods of Analysis* (15th edition). Association of Official Analytical Chemists, Arlington, Virginia, USA.

AYORINDE, K. L. (1991). Guinea fowl (*Numida meleagris*) as a protein supplement in Nigeria. *World Poultry Science Journal.* **47:** (1) 21:26.

GARDINER, E .E and HUNT, J. R. (1984). Water consumption of meat-type chickens. *Canadian Journal of Animal Science.* **64:** 1059-1061.

GOHL, B. 1981. *Tropical feeds.* Food and Agriculture Organization of the United Nations, Rome, Italy.

LUHALOO, M. (1996). Chemical composition of air classified and stack-sieved fractions of a high–fibre rye milling stream. *Critical Reviews in Food Science and Nutrition* **38:** 12 - 17

MARKS, H.L. 1979. Growth rate and feed intake of selected and non-selected broilers. Growth **43**: 80-90

MARKS, H. L. and BRODY, T. (1984). Intake of feed and after following restriction in selection and on selected broilers. *Poultry Science* **63:** 2307-2317.

MUPETA, B. WOOD, J. and MHLANGA, J. (2001). Chemical composition of sieved-fractions of sunflower residue. DFID project R7524. NR International, Aylesford, Kent, UK.

MUPETA, B. WOOD, J. MANDONGA, F. and MHLANGA, J. (2002). The performance of village chickens under improved feed management compared with the hybrid chickens in Zimbabwe. DFID project R7524. NR International, Aylesford, Kent, UK.

NRC (NATIONAL RESEARCH COUNCIL) (1977). *Nutrient Requirements of Poultry* (7th edition). National Academy of Science, Washington. DC, USA.

NEWTON, G. L. BOORAM, C. V. BARKER, R. W. and HALE, O. M. (1977) Dried *Hermetia illucens* larvae meal as a supplement for swine. *Journal of Animal Science* 44**:** 395-400.

PASTERNAK, H. and SHALEY, B. A. (1983) Genetic-economic evaluation of traits in broiler enterprise; reduction of food intake due to increased growth rate. *British Poultry Science* **24:** 531-536.

PATULLO, I. (1987). Introduction to dairy farming. In: *Dairy Farmers Handbook*. pp 4-6 (ed. J. Oliver) National Association of Dairy Farmers, Commercial Farmers Union, Agriculture House, Harare, Zimbabwe

SEN, M. and BHATTACHARYYA, D.K. (2000). Hypolipidemic effect of enzyamatically extracted sunflower seed protein fraction. *Journal Science Agriculture* 0022 – 5142/2001.

SINGLETON, V.L. and KRATZER, F.H. (1969). Toxicity and related physiological activity of phenolic substances of plant origin. 1 *Journal of Agricultural and Food Chemistry* **7:** 497-512.

SMITH, K. J. (1968). A review of nutritional value of sunflower meal. *Feedstuffs (USA)* **40:** 20-22.

SONAIYA, E.B. (1997). African Network on Rural Poultry Development: Progress Report, November 1989 to June 1995. Proceedings ANRPD Workshop, Addis Ababa, Ethiopia. pp. 134-143

SUGIMURA, K. HORI, E. KURIHARA, Y. and ITOH, S. (1984). Nutritional value of earthworms and grasshoppers as poultry feed. *Japanese Poultry Science* **21:** 1–7.

WISEMAN, J. SALVADOR, F. and CRAIGON, J. (1991). Prediction of the apparent metabolisable energy content of feed for broiler chickens. *Poultry Science,* **70**: 1527-1533.