Integration of organic poultry in whole farm systems: manure nutrient budgets

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ABSTRACT

The aim of this project was to examine how rotations incorporating organic poultry use the cycling of nutrients between soil, crops and birds. Poultry studies have measured nutrient values of manure in slow growing meat birds at about day 81 when fed typical broiler rations versus “Label Rouge” rations. Nutrient (N, P, K) balances were constructed to assess the viability of integrating poultry production within a theoretical organic rotation. The readily-plant-available nitrogen in manure from Ross 308 birds fed either presumed non-limiting rations or Label Rouge rations was within the range reported for intensive broilers. For ISA 657 birds, the manure readily-plant-available nitrogen was similar to the mean value reported for broilers, when fed presumed non limiting rations, but towards the lower range when fed Label Rouge rations. As breed growth and feed intakes differ it is suggested that to optimise the utilisation of nutrients, the nutrient content of table bird manures should be checked prior to land application. The nutrient budgets were similar for N and P regardless of the length of rotation or form of poultry production. On average, there was a surplus of 85 kg/ha N over all the scenarios. There tended to be a deficit of K in all scenarios (average: 10 kg/ha).

Keywords: organic poultry, farm rotations, manure nutrients, nutrient balance

INTRODUCTION

The aim of this project is to examine how rotations incorporating organic poultry use the cycling of nutrients and waste between the soil, crops and birds. It will be important for organic farmers to know whether quantities and availability of N, P and K within the system are likely to be limiting, or whether there will be a surplus. The information will be of use to existing organic poultry producers and to organic farmers wishing to develop a second or third enterprise.

One way of assessing the sustainability of a farming system is to construct a nutrient balance. This is a nutrient accounting process which sums all the inputs and outputs to a given, defined system. Comparison of nutrient inputs with outputs provides an indication of the likely change in soil nutrient status over the longer-term. Whole-farm nutrient balances (or budgets) are not only a way of assessing the viability of farm rotations, but can also be used to determine best management practices, predict the impact of changing practices and compare systems.

MATERIALS AND METHODS

Nutrient (N, P, K) balances were constructed to assess the viability of integrating poultry production systems within a typical (theoretical) organic rotation. This included one or two years of grass/clover ley as the initial fertility building phase, followed by potatoes and wheat, with a crop of peas to boost soil fertility and ending with a second wheat crop. Farmgate and soil surface balances were calculated for this rotation assuming part of the ley was utilised by either laying hens or table birds.

Several different scenarios were considered in the construction of farmgate and soil surface nutrient (N, P, K) balances for the rotation described above: a 6 course rotation (2 years grass/clover ley prior to the arable cropping) with laying hens or table birds compared to a 5 course rotation (1 year grass/clover ley) with laying hens or table birds. The farmgate balances included inputs of nutrients by atmospheric deposition and nitrogen fixation, purchased seeds, animals (table bird chicks only), feeds (feed protein) and bedding materials. These were compared with the output of nutrients in sold plant (potatoes/peas) and animal (eggs/birds) products. The soil surface balances also included nutrient inputs as atmospheric deposition, nitrogen fixation and seeds, but feeds, purchased animals and bedding materials were excluded as these should be accounted for by including animal manures as an input. These inputs were compared with the output of nutrients in all harvested plant products (including those recycled on-farm), nitrate leaching losses and ammonia volatilisation losses following manure spreading.

RESULTS

Manure nutrient values

Nicholson *et al.,* (1996) reported the nutrient composition of conventional poultry manures in England and Wales, including free range layer manures and broiler manures. The nutrient composition of organic layer manure is expected to be similar to those for conventional free range layers, provided that the feed specifications and protein digestibilities are similar between systems. This is because modern layer hybrids are used in either system, and for the above circumstances egg outputs are not expected to be better or poorer than for conventional egg layers. Furthermore, there is at present a derogation to EC 1804/1999 which permits the use of synthetic amino acids in organic poultry feeds on a health and welfare basis. Thus, diet specifications for use in conventional free range and organic systems of egg production are likely to be similar.

The nitrogen value of organic table bird manure may differ from that of conventional broiler manure. This may be due to breed differences in feed conversion efficiency throughout the growing period and differences in the dietary nitrogen content between conventional broiler rations and organic table bird rations. Regulation EC1804/1999 and UKROFS Standards require the finisher ration to be comprised of cereals at a proportion of 65% of the ingredients. The high cereal component of the ration dilutes the dietary nitrogen content of the organic ration, compared with conventional broiler rations.

DEFRA-funded projects OF0153 and OF1063 have provided some information on the manure nitrogen values of indoor table birds fed Label Rouge rations. The dietary specifications of the Label Rouge rations were similar to those of feeds used for organic table birds. Although synthetic lysine and methionine were used in the Label Rouge rations their inclusions in the diets were at concentrations commensurate with meeting the birds' needs for health and well-being, and not at concentrations aimed at optimising growth. By way of example, the manure nitrogen values of indoor table birds fed *ad libitum* on either presumed non-limiting rations or Label Rouge rations are shown in Table 1 for hybrids commonly used in extensive systems.

Table 1. Total nitrogen, ammonium-N and uric acid-N in manure sampled from indoor ISA 657 birds (widely used in Label Rouge table bird production) fed either presumed non limiting rations (NL) or Label Rouge rations (LR), compared with published values for conventional broilers

	NL	**LR**	**Conventional[a]**
Dry matter (%)	65.3	69.9	64.2
Total N (%dw)	5	4	5
Total N (kg/t fw)	33	25	33
NH_4-N (%dw)	0.8	0.5	1
NH_4-N (kg/t fw)	5	3	6
Uric acid-N (%dw)	0.8	0.2	0.7
Uric acid-N (kg/t fw)	5	1	4

.[a]*Nicholson et al, 1996*

Nutrient balances

The farmgate nutrient budgets were very similar for N and P regardless of the length of rotation or form of poultry production. On average, there was a surplus of 85 kg/ha N over all the different scenarios, with the surplus being slightly greater from table bird production and from the 6 course rather than 5 course rotation. This was due largely to a greater input of N in purchased feeds for the table birds, as 4 flocks could be sustained within one year, compared to just one flock of laying hens. Also, 2 years of grass/clover ley in the 6 course rotation provided greater potential for N inputs by fixation. The P balance was near break-even for the farmgate budgets, with a small average surplus of about 2 kg/ha. This was greater for laying hen production due to a smaller output of P in sold animal products. There tended to be a deficit of K in all scenarios (average: 10 kg/ha), except for table bird production where some of the cereals had to be purchased (5 & 6 course rotations). The deficit was largest for laying hen production, which had a lower input of K in purchased feeds.

The difference in N content between Non-limiting and Label Rouge manures shown in the table means that it is important for farmers to obtain accurate manure nutrient analyses prior to land application, rather than to simply assume that their poultry manure is of a "standard" N content.

There was also a surplus of N in the soil surface balances, but it was much lower (average: 27 kg/ha) than that in the farmgate balances, probably because losses of N via leaching and ammonia volatilisation were included which reduced the surplus. In contrast, P surplus was greater in the soil surface balance compared to the farmgate balance because the output of P from harvested crops (considered in the soil surface balance) was much less than that from sold plant and animal products (considered in the farmgate balance). The K deficit was also greater in the soil surface balance compared to the farmgate balance for table birds, but smaller in the case of laying hens. This was due to greater output of K in harvested crops (soil surface) compared to sold plant and animal products (farmgate) for the table birds, but a higher input of K in manures (soil surface) compared to purchased feeds (farmgate) for the laying hens.

CONCLUSIONS

The readily-plant-available nitrogen supply of manure from Ross 308 birds fed either presumed non limiting rations or Label Rouge rations was within the range reported by Nicholson *et al.,* (1996) for conventional broilers. For ISA 657 birds, the manure readily-plant-available nitrogen supply was similar to the mean value reported by Nicholson *et al.,* (1996) for broilers, when ISA 657 birds were fed presumed non limiting rations, but it was towards the lower range when fed Label Rouge rations. The dry matter content of litter from I657 birds Label Rouge rations was higher than the mean value reported for broiler litters (about 70%, compared with about 60%, respectively), and the total nitrogen content was slightly lower (about 4%dw, compared with about 6%dw). As breed growth profiles and feed intakes will differ it is suggested that in order to optimise the utilisation of manure nutrients, the nutrient content of table bird manures should be checked prior to land application.

The construction of nutrient balances for assessing the viability of organic poultry production systems has demonstrated that a ‘closed’ system where all the inputs can be supplied on-farm is currently not achievable. Some feeds, particularly protein sources, have to be purchased externally and these provide a valuable source of nutrients (particularly P and K), which are in deficit on many organic farms. However, although the principle of a closed cycle is fundamental to organic farming, it need not necessarily apply at an individual farm level (Lampkin, 1990). On a regional scale, it does not matter if the feed crops, the poultry and the land upon which the manure is used are in different locations (Charles, 1996).

It is important to sound a note of caution. Nutrient balances provide only a guide to the potential viability of a rotation or farming system, not least because there will be errors associated with the assumptions and calculations (crop and manure nutrient contents, for example). The main N inputs are from biological N fixation and purchased feeds (or manures in the case of the soil surface balance). N fixation is difficult to measure, particularly at a farm scale. The actual amount fixed will depend on a number of factors, including soil type, climate, clover cultivar, proportion of clover in the sward and age of the sward. As fixation forms a major N input into the balance, any variation in the estimates used is likely to have a large impact on the overall balance. Manure nutrient analyses are also notoriously variable, which could also lead to error in the overall soil surface balances.

ACKNOWLEDGEMENTS

This work was funded by the UK Department for Environment, Food and Rural Affairs (DEFRA).

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From: Powell et al. (eds), *UK Organic Research 2002: Proceedings of the COR Conference, 26-28th March 2002, Aberystwyth*, pp. 237-242.