

CHAPTER VIII

GENERAL DISCUSSION AND CONCLUSION

Focus on nutritional studies in communally managed livestock in Zimbabwe reflects a need to address the problem of general underproduction in this sector. Farming systems at the time of this study were such that nearly 80% of the population owning more than 68% of the national cattle herd and almost all the national goat population occupied less than 42% of the total land area (Ministry of Mines Environment and Tourism, 1998). The majority of these areas fall in regions 3, 4 and 5, generally characterised by poor terrain, poor soils, where rainfall is unreliable or more erratic. In some areas of Matebeleland North and South, desertisation is encroaching. Such a situation is worsened by overstocking as livestock are family owned, although they graze communally resulting in over-grazing. Communal production systems are generally low input production systems due to resource-poverty and, in particular cattle, are seen as multi-functional utility animals rather than as commercially tradeable assets. Milk however, is more valuable to household and community nutrition, although its output levels could be increased through improved animal nutrition. Government policy strategies and a number of schemes over the past 20 years have been focussing on communal areas to improve livelihoods and incomes through increased productivity in agriculture.

Nutritional stress is an important factor under these communal farming conditions. In addition to inadequate biomass, the level of micronutrients that in commercial livestock farming are ordinarily supplied through supplementary feeding, are unaffordable or inaccessible to the generally resource-poor communal farmers. The

number of micro-nutrients which can affect production and productivity are however many, and a number of them may interact antagonistically while others interact synergistically (Meyer *et al.*, 2000; Nielsen, 2000; Boland, 2003). Their availability may also be affected by various other macronutrients. In the case of iodine, protein levels are important as they bind iodine (Osorio, 1967; Irvine, 1969), making the otherwise volatile element more stable. Local laboratory diagnostic experience indicates that hypoproteinemia in communal cattle is not unusual, being a result of under-nutrition and helminth infestation. Goitrogens in the feed on the other hand, may interfere with availability or metabolism towards formation and potentiation of thyroid hormones which are essential for a number of metabolic processes of growth and other performance criteria (Underwood, 1971).

This picture, against a background of simple iodine deficiency goitre in the human population was assumed to imply iodine deficiency conditions in livestock. Without reference local values for normal performance, the findings of this study dwelt on the variations that were observed through proxy measurements of FT₄ and associated iodine levels in pasture materials. Low thyroxine levels were expected in areas like Wedza and Chikwaka that were historically associated with human goitre (Todd *et al.*, 1989). This was, however, not evident during this study despite that in both these areas there was visible and palpable goitre in goat kids. This situation may be as a result of differences in feed bases. Cattle are grazers while goats are browsers, in contrast with humans whose direct reliance on natural plant material is relatively minimal. The feed base for goats may therefore be contributory. The levels of hormone found in goats were at least double those of cattle. This might mean that goats could be more susceptible and more prone to goitre when deficiency levels

prevail. In more recent years, an iodine supplementation programme through mandatory importation of iodised salt has reversed the hypothyroidism problem in the human population in Zimbabwe. Following several years of a national supplementation programme for humans, it has been recorded that some former human patients were being reported hyperthyroidic (Marima-Matarira, 1998). Public health programs have however resulted in greater usage of pit latrines at virtually every village, than was the case before 1981. Therefore, measures taken to correct hypothyroidism in man have limited, if any, effect on livestock.

While FT₄ may indicate iodine status, the fact that it is not the form in which the hormone is active may make it a misleading indicator in reflecting the metabolic and growth effects of iodine. An increase in the formation of FT₃ by conversion of T₄ leads to higher energy metabolism and protein formation (Underwood, 1971), as may happen in the younger cattle under euthyroidic conditions. While FT₄ may be a highly sensitive, specific and therefore reliable indicator for human thyroid function (Nelson and Wilcox, 1996), considerations are indicated in interpreting cattle data since the relationship of weight with FT₄ varies with age (Kahl and Bitman, 1983). This situation where T₄ varies positively with T₃ during growth and development phases, while varying inversely in adult phases, reflects differences in metabolic needs with age. It may therefore be important to consider T₄ levels in light of feed iodine as well as FT₃ levels and total protein bound iodine. Interpretation of results therefore requires to be specific as enterprises like dairies may retain mature animals longer, while beef operations may have a preponderance of younger animals. For mixed operations similar to communal production, age-specific reference data are necessary for diagnostic accuracy. Sampling in the field will therefore need to bear this in mind.

In human subjects, low FT₄ levels have been said to reflect hypothyroidism, while high FT₄ levels indicate hyperthyroidism. This situation may be to do with the high usage of physical measurements in young subjects, meaning that serum FT₄ in thyroid diagnostics tends to be used for adult human subjects to determine sub-clinical ailments. The parallel with animals is that herd or flock diagnoses are often necessary for decision-making and, while goitre may be easily observable in neonates and younger animals, it may not be easy to assess hypothyroidism in adults. It is therefore necessary to determine age cut-off points for diagnostic reference data.

Offtake rates in cattle areas may result in a higher populations of younger growing animals whose FT₄ levels are lower because of metabolic needs (Rumsey *et al.*, 1990) and this might be a factor in regions where beef production may be the most important enterprise. For other communal settings, while increasing growth and age may result in lowering of FT₄, lactation and sex of the animal are unlikely to affect the FT₄ levels especially in the more mature animals. It is however, important to note that iodine deficiency in cattle is not as extensively documented as for other domesticated species, for example canines.

While a station experiment appeared to indicate the opposite, it appears that the apparent faster growth of beef cattle in the mopani woodlands of region 4 might be due to a metabolic pathway which limits the utilisation of iodine in the formation or accumulation of thyroxine. This is because in this region, forage iodine levels are high by local standards and yet free thyroxine levels in serum are lowest. Region 4 being one of lower agricultural crop potential, is important for livestock, particularly beef. Such a situation could reflect higher rates of deiodination of T₄ or a bias for formation of T₃, hence muscle growth. On the other hand, it might reflect

hypothyroidism from secondary factors, leading to higher water, salt retention and fat deposition due to low FT₄ (Robertson et al., 1957; Stasilli et al., 1960; Hillman and Curtis, 1979). Of interest is the contrast among the agro-ecological regions. Total pasture iodine levels measured by the iodide ion selective method indicate that environmental iodide levels are likely to increase as regions become drier or more low lying, as this study found in region 4. High levels in region 2a might be a reflection of the region being a derivative source from weathering rock. Region 5 is generally in lower altitude of desertified areas or lower flood plains such as Muzarabani and the lower levels of iodide ions (Chapter IV) might be due to factors associated with these characteristics.

A pattern in which FT₄ varies positively with iodine availability would have logically been in line with higher thyroid hormone levels in regions 3 and 4 as forage iodine levels are likely to be higher in these regions (Chapter IV). Indeed higher pasture iodide levels were associated with higher FT₄ in region 2a. The opposite was however, true where FT₄ levels were higher in the higher lying wetter regions 2b and 3 with lower forage iodine than in region 4 with higher forage iodine.

In comparison with values obtained in other parts of the world (NRC, 1984; ARC, 1980), the pasture iodide levels found in this study, ranging from 4 µg/kg (regions 2b and 3) to 41 µg/kg in region 4, were on the whole far too low to meet the recommended daily intake requirements of about 30 to 40 mg per day. Unless normal values for Zimbabwe are different, these levels may compromise performance of livestock raised on natural pasture in communal areas without other forms of nutritional supplementation. This is bound to be worse for dairy cattle and small stock whose milk iodide component is proportionately higher. In such situations,

supplies of iodine from meat and milk alone in human diets will not meet the daily human dietary requirements unless other sources such as iodised salts are part of the diet. This is because of the low quantities of milk produced as well as the iodide levels likely to be in them.

Breed improvement in communal areas has been encouraged through extension for many decades. Cross-breeding was evident in the field and involved breeds such as the Afrikaner which have been found by others to be carriers of the thyroglobulin gene (Ricketts et al. 1985). It will therefore be necessary to include breed as a factor in seeking an explanation for low thyroid hormone (FT₄) in follow-up studies. Classification of this factor proved to be too crude to permit a meaningful analysis in cattle.

It remains unclear why supplementation studies in region 2a failed to lead to productivity gains while higher environmental iodine in region 4 was associated with apparently faster growth. The higher levels of FT₄ in region 2a could however be a reflection of failure of metabolism due to factors rendering the hormone inactive (Beckett et al. 1987; Arthur et al. 1988). The reversal in relationships between FT₄ and FT₃ due to supplementation is similar to findings in studies involving a range of antithyroidic formulations (Hemken et al., 1965; Kahl and Bitman, 1978). It may also be related to the form and dosage in which the iodine preparation is presented. Miller and Swanson (1973) recorded higher bio-availability with organic iodide forms such as EDDI.

While this study has documented the thyroid status of local livestock (cattle and goats), the observed values stimulates further research interest to confirm them. In the

follow-up studies, the designs should take into account such factors as production performance, age, breed, and all agro-ecological regions of Zimbabwe.

Since values recommended or found elsewhere (Refetoff, 1970; Underwood, 1971; La Croix and Wong, 1980; NRC, 1984), both serum FT₄ and forage iodide levels were far higher than expected for cattle to perform optimally, attempts were made to raise the levels and hence performance. This was done through supplementation trials, which however failed to translate remarkably into a change in productivity levels in terms of weight gain in experimental station calves. This of course could mean that the iodine values naturally occurring on this station were good enough to sustain a euthyroidic status in these calves. This could indeed be true as Mazowe station lies in region 2a where both hormone and iodide levels were higher than in other regions. This finding seems to be vindicated by a field trial in which iodine was given as dietary supplement in which crude protein and other macro-mineral supplements were included. The response to iodide treatment was not as remarkable as that obtained when the same blocks but without iodine, were fed to a different group simultaneously. This field trial was conducted in region 2b where forage iodide levels were significantly lower than in region 2a, 3, and 4. Therefore the response to iodine supplementation was expected to be higher than that obtained. Different factors could have interfered with effectiveness of iodine supplementation in both trials. One factor could be the nature of organic complexing necessary to maximise availability of iodine.

Currently available RIA kits for FT₄ and FT₃ are applicable for the routine diagnosis of thyroid condition in cattle and other farm livestock (Millar and Albyt, 1985). The findings of the present studies indicate that it may always be necessary to run tests for

both FT₄ and FT₃ on the same sample in order to arrive at meaningful interpretations. This is because the relationship between them and other hormones such as Growth hormone, and TSH; goitrogens and genetic influences as well as other trace elements like selenium may indirectly cause thyroid hormone changes despite the iodine availability situation. It is also possible to apply the ion selective electrode methods to assess iodine in feeds, urine and milk.

As epidemiological tools, the methods used need to be evaluated against each other for their reliability and reproducibility. This could be done through validation exercises in which other tests are used for comparisons. Immunological tests are a more convenient way to make inferences about herd performance in relation to spatial and temporal factors. These could then be used in compiling information for advice to farmers. A complication remained with the ELISA for TSH. Cross-reactions with other gonadotrophic hormones which, contrary to other reports (Borger and Davis, 1974), could not be cleared by pre-adsorption with those gonadotrophins in this study. In addition, the difficulty in securing suitable control reagents and purified or more exacting test components defeated the test trial. The ELISA will be a valuable safe and more efficient tool in thyroid status assessment provided this impediment is resolved, especially given that small changes in T₃ and T₄ within normal ranges are not detectable by simply assaying the two (Ridgway, 1996). Another diagnostic system to indicate when thyroidal secretion of T₃ and T₄ become significant, is necessary.. Both the ELISA and the RIA will however depend on the ability to have local, more cost-effective means for reagent generation, including the process of antigen and antibody marking and standardisation. It will also be necessary to research further on the conditions for pre-adsorption of non-specific sera and the local

production of sub-unit monoclonal antibodies to increase the discriminatory power of the test.

In conclusion therefore, the studies recorded here have placed the thyroid function status of cattle in the context of the local environments. Values thus established can be used as reference points for other studies. In general, it can be surmised that the local environments are deficient in iodine. The effect of this deficiency may manifest itself more easily in goats as goitre. In cattle, however, effects in terms of productive performance like milk production may be important but marginal. It is however, possible that other productivity measures may be more sensitive if further investigated.

Various laboratory diagnostic methods are available for use in assessing thyroid function in animals that can be used locally. The present study showed that it is possible to rely on RIA and the ELISA for serum thyroid hormone levels, and on the ISE for iodide estimations. However, further work is needed towards their validation, improving their attributes and, lowering the costs and increasing their efficiency.