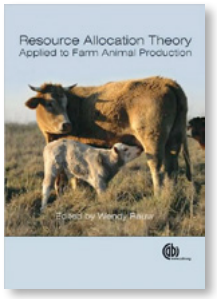
# BIOLOGY TEXTS

## Short Written Texts (Reports)

**University of Nevada-Reno: Department of Animal Biotechnology. Rauw, Wendy (ed).** ***Resource Allocation Theory Applied to Farm Animal Production.*** CABI (2008). *Extracts from pp. 12 & 15.*




Under natural selection, individuals need to be ready at any time to allocate their resources among the demands of maintenance, growth and reproduction, with some amount held in reserve as a buffer. However, in animals that origin from a population that is selected for high production, the weighing given to some other components will be increased. During the domestication process, the relative importance of ability to reproduce in captivity or tameness increased. Subsequently, with active selection, the weighting given to production increased (Rauw *et al.*, 1998; Mignon-Grasteau *et al.*, 2005). Preferential allocation of resources may occur because the animal is 'programmed' to allocate a disproportionally large portion of its resources to a particular one of these demands, leaving it lacking in ability to respond to other demands, such as coping with disease and stress (Siegel and Dunnington, 1997; Rauw *et al.*, 1998). Animals that are genetically driven to produce at high levels may reallocate resources away from other processes, where buffer capacities and traits not defined in the breeding goal may be the first to be affected, because their importance is not specifically recognized (Rauw *et al.* 1998, 1999). In addition, historically, it has been necessary to make changes slowly, giving the whole animal time to equilibrate to both direct and correlated responses. If genetic changes are too radical or sought too rapidly (e.g. with introgression of desirable genes into available populations), new genes may disrupt resource allocation that has evolved gradually, and the homeostatic balance may be at risk (Dunnington, 1990).

Moberg (2000) developed a model of animal stress describing the importance of the cost of the stress to animal welfare. When the cost of coping with the stressor diverts resources away from other biological functions, such as growth, reproduction or the immune function, the animal experiences distress, which places it in a prepathological state and increases its vulnerability to a number of pathologies. Similarly, McNamara and Buchanan (2005) indicate that a reduction in the physiological state resulting from the inability to maintain optimal physiological condition during periods of environmental stress potentially includes reduced physiological reserves of essential vitamins, minerals and amino acids, reduced body condition and immunocompetence, and reduced fat reserves, leading to increased mortality and decreased reproductive potential.

Rauw *et al.* (1998) and Rauw (2007) reviewed the literature on undesirable correlated effects of selection for high production efficiency in broilers, pigs and dairy cattle, and showed that the highly favourable increase in production levels is indeed often compromised by behavioural, physiological and immunological problems. The most striking examples of undesirable correlated responses were reported in broiler chickens with an increasing incidence of heart failure syndrome and leg problems. In poultry, selection has been almost for one trait only, i.e. body weight at a certain age, and selection intensity has been high with a short generation interval. In cattle and pigs, selection has been less intensive, for more traits and during fewer generations, resulting in more controversial results (Rauw *et al.*, 1998).

## 6. Implications

Undesirable effects of increased production efficiency have raised questions about what is ethically acceptable in animal breeding. A question similar to that asked by Corning and Kline (1998) regarding natural selection can be asked with respect to artificial selection: when we speak of a 'breeding goal' do we actually have any particular value in mind, or is the goal simply 'more'? The answer is given by Groen in Chapter 16: 'Genetic improvement is not aiming at an opti-

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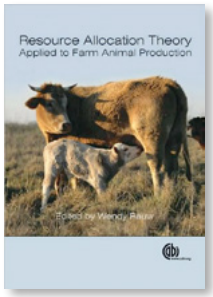


mum; genetic improvement is dynamically searching for improvements. Given animal genetic variation (within or between breeds), there is always a means of improvement.' The key ethical question is not whether animal breeding should be abandoned, but how we should breed (Gamborg and Sandøe, 2003). The general opinion is that it is acceptable to use animals as long as it is done 'humanely' and does not result in physical damage, pain or distress (Christiansen and Sandøe, 2000).

Animal well-being and welfare can be *improved* by breeding as well. Increased emphasis on welfare-associated traits in the selection index, such as longevity and health, will result in improved animal welfare and increased public confidence in animal farming (Pryce *et al.*, 1999; Kerr *et al.*, 2001; Stott *et al.*, 2005). Breeding companies can play an important role in addressing welfare problems by defining broader breeding goals that include not only production traits but also functional traits and non-economic values, such as emotional and societal values (Kanis *et al.*, 2005; Olsson *et al.*, 2006). Every trait that matters must be included in the breeding objective, which necessarily means that improvement must go more slowly in each of the many traits in order to achieve progress towards the total goal (Beilharz and Nitter, 1998; Oltenacu and Algers, 2005). Kanis *et al.* (2005) proposed a selection-index method to obtain the proper weights for societally important traits in the breeding goal, such as welfare and health. It will become clear from Chapters 12 to 14 that breeding programmes are more frequently including functional traits in the breeding goal, and that this is successful. Chapters 16–18 discuss breeding goals, robustness traits and resource allocation models, respectively, as methods to improve the breeding objective.

Falconer (1952) suggested that '[i]t would therefore generally be recommended that selection should be carried out under the environmental conditions in which the improved breed is destined to live'. He also suggested that performance in two different environments (such as on a low versus a high plane of nutrition, or temperate versus tropical climates) can be regarded as two different characters that are genetically correlated. Thus, selection for the character in one environment will bring about a correlated response in the trait in the other environment. But an advantage of selection in the secondary environment would accrue only an advantage through an increased heritability, and this should be great enough to offset the loss of efficiency through selection being made for a character that has not exactly the same genetic basis as the desired character (Falconer, 1952). According to the Resource Allocation Theory, using highly productive animals from populations that were selected in favourable environments, in poorer environments is very likely to cause problems with fitness (Beilharz and Nitter, 1998).

Questions are being asked on the future direction of agriculture in several countries, with special emphasis on the question as to how the agricultural sector can find sustainable ways of being more productive (Garnier *et al.*, 2003; Oltenacu and Algers, 2005). MacArthur Clark *et al.* (2006) recommend the establishment of a committee for the evaluation of welfare problems associated with breeding technologies that would advise on the effectiveness of existing legislations and practices relating to animal breeding procedures to assure animal welfare, and would give consideration to ethical questions associated with animal breeding even where measurable detrimental effects on animal welfare may not be immediately evident. We may expect that increased and combined efforts may result in better animal welfare in the future.