DEFINITION, MEASUREMENT AND RECORDING IN THE INTENSIVE LIVESTOCK INDUSTRIES

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The intensive animal industries wish to utilize and maximize the production potentials of the livestock involved, but within an economic framework determined by the market place. The name of the game has been maximum return per capital input, whether that input be labour, feed, machinery or buildings, and so any genetic program has been directed essentially to maximizing production parameters.

BREEDING ACHIEVEMENTS

1. The chicken meat industry has seen improvement in daily rates of weight gain, an increasing improvement in number of chickens per hen and an increasing awareness of the importance of genetic improvement in food conversion efficiency, although it is only in recent years that any consideration has been given to selecting for efficiency of food conversion directly. Previously any improvement has been a by-product of rapid growth rates with its accompanying reduction in maintenance requirements. Really no considerstion has been given, or indeed has had to be given, in a genetic program, to quality of the product excepting conformation.

2. Similarly the egg industry has seen the emphasis on hen-housed averages although various quality factors (egg size, shell quality etc.) have warranted quite an amount of attention because of their importance in the market place.

3. The turkey and duck industries have followed and are following the chicken-meat industry in the type of genetic development taking place. I say 'followed' and 'following' advisably. Perhaps those responsible for the development of these latter two avian species have not taken sufficient cogniscance of the differences between them and chickens. They have special problems that need genetic inputs additional to those mass selection methods based on weight, that have swept chicken meat production to the status of a major industry all over the world. Broodiness in turkeys, excessive fat and lack of muscle in ducks are problems that the industry recognises (has defined) but is only now commencing to make the required measurements and to record them in such a way that genetic improvement may become possible.

4. The pig industry has possibly seen as great an improvement in production parameters as has the chicken meat industry despite the fact that those responsible for the improvement have been working with far fewer individuals than have been available in the chicken industry. Twenty five years ago it took 12 weeks to produce a 1.5 kg broiler, a weight achieved to-day by about 7 weeks of age. Over the same period we have seen the time necessary to produce a 100 kg pig decrease from 250 days to 175 days. Although that may not appear to be a similar degree of progress, if one were to look only at the improvement in lean meat production, then the progress is about the same. Has the pig industry achieved this progress because they placed more emphasis on definition than did the chicken industry? Perhaps precise definition

wasn't as important in the early days of the chicken industry because of an expanding and non-discriminating market. But would the chicken industry be even more efficient to-day if it had taken cognisance of the fact that fat is an integral part of daily gain and an expensive one in terms of feed consumption?

BREEDING OBJECTIVES

1. Who Shall Decide?

There is a broader sense to definition than just recognizing and stating exactly what is required of individual animals in a livestock improvement program. It is in addition, defining what is required of the livestock industry itself in a production environment that no longer must think of production parameters per se. Once upon a time there was a lucrative livestock industry producing ostrich feathers. But people don't want ostrich feathers to-day. Will they want eggs with their present cholesterol level in 10 or 20 years time?

Accepting that intensification leads to concentrated populations of livestock and therefore probably greater risks of disease to individuals within that population, is prophylactic medication or, frequent therapeutic medication a necessary corollary? And if so, with the possible resultant increase in resistant pathogenic organisms, will the human population continue to support or allow the intensive industries? The geneticist is going to be asked more and more to help breed animals that don't require medication (have an inbuilt viability), to breed birds that lay eggs with minimal cholesterol, to not breed ostriches that do or don't have feathers.

But who will make these broader definitions that look to the future and say what factors are important to the industry x years hence. These definitions are almost management decisions which must take into account politics, availability of resources, the potential of competing industries, consumer variables. They can never be completely accurate definitions but they have to be made. Genetic programs are long term programs and I believe geneticists are doing themselves a disservice if they don't at least attempt to evaluate industry direction, even if they sometimes feel unable to make positive suggestions themselves. Industry personnel may be working so close to production that sometimes they don't recognize the environmental influences that say 'change'. On the other hand geneticists may not be sufficiently involved to be aware of the importance of these influences.

The point I am making is that someone has to define what is required of a particular industry in the future and then precise definitions have to be made of the characters that allow the industry to achieve the requirements. The first definition is likely not to be made by geneticists but the second definition certainly should. The definition of characters for which a selection program is instituted has to be precise but if the prediction (definition) of the direction in which the industry should be heading is incorrect then it is all to no avail. We should be asking ourselves what are the future requirements of the intensive livestock industries, we should be attempting these broad definitions and then defining accurately the characters that may best allow us to fulfill these requirements. Is the cholesterol level in eggs a worthwhile consideration? Should the industry be trying to produce double yolk eggs? If medication of livestock is of concern to the human population how best to select for increased viability?

2. A Change of Emphasis?

a) *Animal Welfare considerations.* The intensive livestock industries have been very much production orientated, and with an ever-increasing intensification of housing and husbandry methods, the raising and care of livestock has given way to economic management calling loudly on technology for assistance. And although this type of assistance has allowed remarkable production achievements to be made, the intensive industries have been increasingly labelled as factory farms and this could prove to be the Achilles heel of these enterprises. Animal welfare bodies, whether they consist of rat bags, do-gooders, concerned individuals, or whatever, will be an increasing part of to-morrows scene. The intensive industries are already aware of them, already realize they can't ignore them, and are slowly getting around to consider what they should do. There are certain features of management and housing that may have to be altered - but on what basis? - because they appear cruel? - because they cause stress? because they deny the animal basic behavioural needs?

The highly organized social behaviour now recognized in animal populations can be seen as a major part of the genetic programing of each social species. And herein lies what I believe to be one of the major challenges, duties of the geneticist who would be involved with the animal industries and more particularly those concerned with the so-called factory farming industries. They have to learn a new vocabulary to understand the language of the animal ethologist, they have to define a code of animal welfare in parameters that can be measured and recorded and then determine their heritabilities. The easy days are over. Maybe blood cortico-steroid concentrations are going to determine whether a husbandry technique or a housing principle is acceptable or not. But Bareham (1972) found no differences between the adrenal weights, pituitary weights, body weights, or circulating heterophil number of hens kept in battery cages or on deep litter.

The problem is a complex one. 'Quite apart from the difficulty of measuring physiological changes in living animals, we are still faced with the problem of relating changed physiological states to the animals subjective feelings of distress. It is possible that animals may suffer to a considerable degree long before physiological symptoms or grossly abnormal behaviour become apparent, and equally possible that animals may not suffer at all even with quite marked physiological changes' (Dawkins 1976). Genetics related to 'livestock improvement' may have a different connotation in the future - rather than seeking to maximize the production parameters of an animal species the geneticist may be as much concerned in defining and selecting animals that can adapt to the husbandry and housing methods of the modern livestock industries.

b) Viability. No one can dispute the importance of viability but how do you select for it? If viability depends on the animal being able to maintain homeostasis in the face of numerous challenges (environmental factors in the climatic sense, potentially pathogenic organisms, or metabolic disturbances) we should be able to define how to ameliorate each of the challenges and to evaluate just what the geneticist has to offer in each area. Let us look at a couple of these areas.

3. Pathogenic Organisms

A wide open field for the geneticist - but beware. Don't look at the trees and forget the forest. It is quite possible to select for resistance to Marek's Disease, a viral disease of poultry. Many companies became involved in very expensive genetic programs to do just that. Marek's disease was causing a heavy mortality in their flocks (up to 30 percent to 20 weeks of age), the parameters leading to resistance had been defined and the heritability was such that worthwhile improvement could be expected. So much so that mortality from Marek's would probably end up no more than 3 to 5 percent over a similar 20 week period. After heavy capital and labour investment I don't think any company ended up with Marek's resistant flocks because an effective vaccine came on the scene which offered them almost 100 percent protection immediately at a fraction of the cost. Certainly this is a continuing cost and there have been subsequent problems with some of the vaccines, but with the technological advances in vaccine manufacture occurring it would be a brave man who would now invest the amount necessary to select for resistance to Marek's disease.

However the immune mechanism of an organism is a very complex structure and it would be naive to think that vaccination technology is going to be the complete answer. The individual's response to vaccination depends very much on intrinsic factors, inherent in that individual, which are genetically controlled. The genetics of disease resistance is a tremendous area in itself. It is in this area that we shall see great advances in the future and, for reasons stated before, more particularly in the intensive livestock industries. Because of the concentration of the animal populations, these industries are at risk from pathogenic organisms. And society may not continue to allow antibiotics to be used as one of the major approaches of the livestock industry to disease control. However, as stated by Newton Norton (1972) in another context 'the population geneticist of to-day has good reason to fear, if he is a biologist, that his mathematical skill will prove inadequate in the future or, if he is a mathematician, that his biological insight will prove superficial'. It does make the point that the future may rest with the team approach.

4. Metabolic Disturbances

Some of these of course are simple gene effects and as such usually exist in a commercial flock or herd, at very low incidence. On the other hand some are hormonally controlled, initiated primarily by extrinsic stimuli and perhaps have as their end - result a facilitation of the invasion of the individual by pathogenic organisms. 'Stress' in a general sense is in this category. This is an area in which I believe genetics is destined to play a big part if the important parameters can be accurately defined and measured, not only to improve viability, but also to identify animals who adapt well to intensification. Tailbiting in pigs may be the end result of many inputs. Poor ventilation, low barometric pressures, external parasites, heavy stocking rates, boredom, and other 'stressful' conditions have all possibly been shown to influence the incidence of this condition in piggeries. A recent (1977) survey in Denmark has shown that 2.25 percent of all pigs slaughtered in that country each year are condemned because of damage from tailbiting. If we could identify and select animals that are capable of adapting well to the modern piggery then possibly much of these losses could be avoided.

The 'fitness' of a population has long been a concern of geneticists working with their laboratory models. Viability of individuals in a commercial animal population has long been a concern of the animal producer.

The geneticist must transfer his understanding of fitness to the commercial field and I believe he may then find his understanding lacks the breadth and depth that is required by the livestock producer. There will become evident a need for futher definition.

SOME COMPARISONS WITH THE EXTENSIVE LIVESTOCK INDUSTRIES

1. Dam Size

In many aspects the intensive livestock industries require a different genetic involvement than do the extensive industries. Both types of industries have shown some concern for dam size as a means of reducing production costs. But when it is realized that the proportion of total food intake of dam plus progeny consumed by the progeny is 90 percent in fowls, 66 percent in pigs, 48 percent in cattle and 28 percent in sheep (Large R.V., 1976) one wonders at the interest in dwarf genes in chickens and ducks, and why there is not more emphasis than that at the moment, placed on size of cows and ewes. And one can readily understand the interest in efficiency of food conversion apparent in the poultry industry. But really it is not until relatively recently that it has been a major consideration in direct selection. It has been a wonderful by-product of selection for rate of gain and of course of major interest to nutritionists.

2. Conformation

Both industries have initially concerned themselves with the conformation of their respective livestock: the large animal industries in the belief that conformation influenced the percentage of more desirable retail cuts and the poultry industry solely to sell a product the consumer found attractive and thought plump and meaty. Both industries have had to rethink their position: the large animal industries because much work has shown very little relationship between carcass conformation and muscle distribution. The intended carcass classification scheme would appear to reduce the importance of conformation as a criterion for which to select. Similar work in chickens has failed to demonstrate that conformation classification identified carcass with different percentages of more desirable body proportions.

As more and more of poultry production moves towards processed products (either simply cut-ups or smallgoods) it becomes important to ask if a consideration of conformation is any longer of value particularly if it reduces the intensity of selection for more worthwhile parameters. On the other hand it may be worthwhile searching the pig and poultry industries for double muscling characteristics as have already been identified in cattle. It is possible or even probable that some of the adverse production effects of double muscling in cattle would not express themselves in pigs (multiple small foetuses) and poultry (possibly no effect on egg size).

The above comments on conformation have referred to shape of carcass rather than other anatomical considerations such as legs, feet etc. With increasing intensification in the pig industry there has been more and more concern with leg and feet abnormalities or 'leg weaknesses'. If we listen to people in the cattle industry, the more extensive the operation the greater is the concern for soundness in feet and limbs. If we listen to people in the pig industry, the more intensive the operation the greater is the concern for soundness in feet and limbs. Have the selection programs practised in the pig industry led to a decrease in soundness and if so is it

simply a nutritional problem (i.e. the 100 kg pig now has only 175 days to receive an adequate amount of calcium or some such substance whereas it previously had 250 days) or are there correlations between various production parameters and limb characteristics leading to unsoundness? Is the flooring in the intensive housing the main culprit (slippery, abrasive etc.), are producers just more conscious of the problems because the pigs' confinement allows close scrutiny, and with their more efficient approach to production are they trying to minimize all aspects that adversely affect financial return.

The literature would indicate there is a considerable genetic component contributing to 'leg scores', but this literature is a classical example of just what this conference is all about. Lack of precise definitions of the problem has resulted in a multitude of results with genetic correlations of one sort or the other with just about every production parameter measured. The results as reported are often valid only for that particular situation at that particular time. They are often of historical value only. And that's not what genetics is all about.

3. Climatic Challenges

In the extensive livestock industries the geneticist has been involved in selecting animals with the ability to adapt to various climatic conditions to increase productivity as well as viability. This has not happended and would not appear to be necessary in the intensive animal industries. The environment itself can be modified albeit often at some expense. So where we have intensive production of livestock with the provision of housing there really has been very little call on the geneticist to select in these animals, populations more suited to the climatic factors than already being used. Probably this will also be true for the future.

MEASURING AND RECORDING

This paper so far has been primarily concerned with definition. The measuring and recording are a waste of time if the definition is not precise. And the measuring of the future will not be of simple production parameters. We are moving into an era where characters will be measured because of genetic correlations. This will be because of:

a) evaluating individuals without lengthy measured production periods

b) evaluating sires without the necessity of progeny tests

c) measuring physiological parameters that are more meaningful than subjective opinions (e.g. animal's reaction to supposedly stressful situations).

Actually the 'In Thing' is the measurement of any number of physiological and biochemical parameters that are part of the metabolic profile of an animal. In general blood protein types would appear to be useful as genetic markers in possibly all species of animals. And indeed as our knowledge of these blood protein systems increase and our methods of defining and measuring them become more sophisticated it appears to me quite possible that genetic programs in the future will rely very much on blood antigens as the selection criteria rather than production parameters per se. But many of the other blood traits investigated such as Hb, glucose, urea, cholesterol, creatine, protein-bound iodine, calcium etc, etc, etc have been declared by some to be

of no use as predictors of performance characters.

As mentioned several times already we are not only interested in performance characters but also adaptability to husbandry situations and suitability of the end product. In pigs there is considerable problem in some breeds with a pale soft watery lean meat condition (P.S.W.). This condition has been defined very nicely over the last decade and has lent itself very well to identification by other than direct means allowing breeding programs to be evolved based on measurement of physiological parameters.

Ultrasonic evaluation of fatness and meatiness in pigs, sheep and cattle have long been with us. It is interesting to see this form of measurement now being applied to chickens but one wonders if linear measurements of lean meat really can be used to influence total yields of lean meat. And in view of the fat distribution of poultry such instrumentation may be far less effective in reducing fatness in chickens than selection for efficiency of food utilization. A similar argument exists for the use of radiology for determining vertebrae number in pigs. Certainly the length of the pig can be influenced by selection for number of vertebrae but does that necessarily increase muscle mass? Perhaps such a technique in conjunction with measurement of cross-sectional area of longissimus dorsi muscle may lead to productivity gains.

In addition to physical measurements such as rate of gain, chemical determinations etc. there is a type of measurement that describes physiological states, for example measurements of reproduction. These describe many facets such as male and female mating behaviour as well as functional normality of ova, spermatazoa and resultant zygote. Any hormonal upset leading to non-expression of oestrus, failure to ovulate, abnormal mating behaviour has to be recognized, defined, measured and recorded so that the cumulative data can be used as a basis for correction of the problem, which may be a management problem but could quite easily be a genetic problem.

Until an area of interest is recognized it can't be defined. We have to recognize the animal welfare considerations of production. It may be a new field to geneticists but basically it requires no different an approach than already used in genetic investigations of reproduction. We shall need to look at hormone assays, at objective, statistically designed behavioural studies. At this stage we are only at the recognition stage, the definition has commenced but will be subject to much controversy and deliberation for some time yet. It is fortunate we have entered the computer age because we are no longer dealing with simple Mendelian characters. The inclusion in a genetic program of behavioural characteristics which have a bearing on aspects of animal production that are not necessarily correlated with production parameters per se would be a new philosophy to both geneticists and producers. But it may be necessary.

CONCLUSION

Geneticists have had an enormous influence on the intensive animal industries. This has been facilitated by the managerial structure of these industries, by the large population sizes under single management control, and by the fact that by and large the measurements and records necessary have not been terribly sophisticated and have been understood and appreciated by management. The industries are accepting more sophisticated record

keeping devices because they allow the situation to be more completely analyzed and, in fact there is a cost saving. However more sophisticated measurements are likely to involve the companies in greater costs. Genetic progress in these industries may very well slow down unless you people realize you have to market your product.

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