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ANIMAL SCIENCE AS A BRIDGE BETWEEN LIVESTOCK FARMERS AND CONSUMERS

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INTRODUCTION

The Agricultural Policy for Nigeria (1987) has the following objectives for livestock production:

1. Make Nigeria self-sufficient in livestock products;
2. Improve the nutritional status of Nigerians by provision of livestock products;
3. Provide locally all necessary raw material inputs for the livestock industry;
4. Allow for a meaningful and efficient use of livestock by-products;
5. Improve and stabilise rural incomes from livestock production and processing;
6. Insure the rural livestock farmer against the risk to livestock production;
7. Provide more rural employment through livestock production and processing;
8. Maintain the ecosystem for expanded livestock production.

Animal scientists have made significant contributions towards the achievement of these objectives through their research efforts and services rendered to various public institutions. They have served: on the expert committees that prepare livestock information packages; as expert consultants to commitees of the Federal Department of Livestock and Pest Control services; on the Livestock Development Projects' panels and on the National Advisory Committee on Animal Research as well as on its various sub-committees.

Perhaps one of the most recent efforts of Animal Scceintist towards the achievement of these livestock objectives was their service in the Presidential Task Force for the Formulation of Alternative Feedstuffs for Livestock. This Task Force directly contributed to the achievement of objectives 3 and 4 and indirectly to objectives 1 to 7.

Within the last 10 years, there have been increasing concerns about the role of animal production in modern societies. The primary concern is with resource depletion and degradation - grassland degredation, loss of soil-conserving vegetation, loss of nutrients and organic matter from soils, methane

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emission by ruminants that contribute to global warming, ammonia emmision from intensive pig and poultry farms or cattle feedlots that result in acid rains, nitrates in water from animal wastes and rapid loss of animal genetic diversity. In addition, questions have been raised about health hazards from meat and egg consumption and about the propriety of feeding grains to livestock. The challenge now facing animal scientists is not only to contribute towards increasing the income of livestock farmers but also to work towards enhancing the quantity and quality of animal products for the consumers.

ANIMAL PRODUCTS, THE BRIDGE TO THE CONSUMERS

In the first Nigerian textbook on animal products ever written to my knowledge (Sonaiya, 1948a), we describe animal products as: " the raw materials that are derived entirely or mainly from the body of animals of their carcasses:. The main animal products are meat, milk and eggs. Each animal product is studied as an independent pure and applied discipline: Meat Science and Muscle Biology, Meat Technology; Dairy Science, Dairy Technology; Egg Science, Egg Technology. In many institutions in Nigeria, the pure sciences (Meat Science, Dairy Science and Egg Science) are taught in the Department of Animal Science, while the applied science are taught in the Department of Food Science and Technology. Regardless of where studied, consumers are attracted to animal products by the quality attributes to tenderness, juiciness and flavour.

When I was recruited in 1977 to pioneer the field of Meat Science and Muscle Biology in the Department of Animal Science, my background was in Animal Nutrition in which I completed the Master of Philosolphy degree. Hence, during my doctoral studies at Cornell University (1977-1989), I had no home-related animal products priority to guide me. I finally decided to work on the effect of electrical stimulation on the carcassess of beef and sheep. In the developed countries of the 1970's, this was an area rich in historical perspectives and industrial application. It had been stated that, in 1749, Benjamin Franklin, the legendary American scientist and statesman, found that "Killing turkeys electrically, with the pleasant side effect that it made them uncommonly tender, was the first pratical application found for electricity".

Electrical stimulation of meat carcasses involved the passage of electricity through the carcass at some point in the slaughtering and dressing process. Electrically induced contracture of the muscles of the carcass hastens the normal biochemical and physiological events occuring in muscle after death, i.e., depletion of energy stores, decline in muscle pH and the onset of rigor mortis. Within a few years of the reports from New Zealand suggesting that eletrical stimulation prevented cold shortening, the pratice spread to virtually every developed country. In Sweden, for example, more than 90% of the beef meat produced was electrically stimulated.

The reason for the great interest in electrical stimulation was the need to avoid cold and thaw shortening, two quality-damaging phenomena occuring in meat that was not allowed to go into rigor mortis before it was refrigerated of frozen. Such meats become incredibly tough and virtually inedible, even for the African! Electrical stimulation of the animal carcass soon after slaughter has proved to be one way of hastening the development of rigor mortis and significantly reducing the time before meat can be frozen.

This seemingly esoteric piece of research had a salutary effect on my career development. Shortly after publishing our findings (Sonaiya and Stouffer, 1982; Sonaiya, Stouffer and Beerman, 1982) and presenting them at the International Congress of Meat Reseach Workers in Madrid, I was invited in 1983 by the Food and Agriculture Organization of the United Nations (FAO), for the first time, to serve as a consultant on slaughter house operations and slaughter house personnel training in Malawi, Tanzania and Zambia. My preparation in Meat Science was also very beneficial to another set of consumers - my students. It helped me in the introduction and development of the course contents of the final year undergraduate course, Animal Products, and the postgraduate course, Animal Growth and Development.

Even without the application of external electrical energy, it appears that some edible animal products contain more energy (e.g. chicken egg, 6.82KJ/g) than the body of the animals (chicken, 4.89 KJ/g). But how do we know this? In the Scientific Era, pioneer work on the determination of the chemical composition of the live body and carcass of domesticated species was done by Lawes and Gilbert in the mid 19th century in England. To date, the methods used in this area of study are grouped into three, namely:

(a) Methods that are useable on carcasses alone i.e., anatomical dissection involving physical separation of bone, muscle, fat and skin. This is the "classical" approach.

(b) Methods that are useable on both live animals and carcasses i.e., ultrasounds, X-ray, specific gravity, body lenght, circumference, fat depth; and

(c) Methods that are useable on live animals alone, such as the dilution techiques for tritiated water (^3H_2O), ^{40}K and ^{51}Cr as well as the estimation of antipyrine content of body fluids.

In our study of the chemical composition of the bodies of domesticated animals, we have had the opportunity, in collaboration with senior and junior colleagues, to use each of these three methods. As an M. Phill. student under the supervision of Professor Wale Omole, I employed body lenght and fat depth measurement to estimate the energetic efficiecy of cassava meal and cassava peel meal diets in local and exotic pigs (Sonaiya and Omole, 1971; 1983; Sonaiya, Omole and Adegbola, 1982). Fifteen years later, I directed Ayodeji Komolafe in the use of the classical anatomical dissection method of

Lawes and Gilbert for the study of dietary energy partition into body tissues by Nigerian indigenous,pigs. As a Reseach Associate of Professor Jim Stouffer of Cornell University (the father of Animal Ultrasonics) during the summers of 1984 - 1986, we developed ultrasonic procedures for instrument grading of beef. In foundation, Inc., National Livestock and Meat Board and the New York State Department of Agriculture and Markets, we used the attenuation of the ultrasonic signal to estimate the amount of discontinuities in the *M. Longissimus dorsi,* which are attribute to fat globules and hence to marbling (Sonaiya, Stouffer and Cross, 1992a,b).

Regardless of the method used, the energy value of the fat free body weight is remarkably similar, indicating that fat energy is the main source of variations (from 4% to 43%) in the body energy content among the various species. The animal body at chemical maturity consists almost entirely of water, protein, ash and fat. The last three chemical fraction correspond to the primary tissues of muscle, bone and fat. The efficiency of depositon of these chemical fractions varies so widely between these primary tissues. It is, in young sheep for example, 80g/d for fat, 56g/d for water, 17g/d for protein and 5g/d for ash. As the growth curve of these tissues indicate, fat deposition ensues latest and, as soon as it starts, the efficiency of conversion of feed energy to body (fat) energy drops sharlpy. Because muscle consists of 70 to 75 per cent water, the feed energy costs for tissue protein and fat are both about 54 KJ/g. Therefore a reduction in fat improves feed efficeincy greatly while an increase in fat depositon reduces feed conversion efficiency. With increasing age and physiological maturity, the efficiency reaches a nadir beyond which it is not economic to continue to even feed the animal. The slaughter point indicated by the energetic efficiency is usually well beyond the point of diminishing economic returns (Soyaiya, 1981, 1982).

There is no such a thing as a fat-free animal. Even newborn animals contain fat because it is essential for life. It serves as the support for membrane structures. It serves as emergency storage for energy. It protects vital organs and provides cushioning for joints during movement. Fat is a biological reality that animals are made tolive with - not without! Fat is distributed throughout the body. It is under the skin, between and among the muscles, in the marrow of bones, around organs and in the visceral linings. The rate at which feed energy is channelled into fat tissue and the pattern of its deposition in the body often dictate the difference between profit and economic ruin for the animal producer.

For about 10 years, we examined the role of internal and external energy fluxes on broiler chicken production and the quality of the final product. Our first series of investigation was centred on the energy (fat) content of broiler carcasses. Our results (Sonaiya and Benyi, 1983; Sonaiya and Okeowo, 1983; Sonaiya, Williams and Oni, 1986) showed that below 1 kg body weight, fat deposition is minimal and economic but beyond 2 kg body weight, the rate of fat deposition is uncontrollable. Our attempt to control fat deposition by Manganese supplementation was unsuccessful (Sonaiya and Kabaija, 1987).

From the hundreds of body fat analyses we carried out, it was apparent that body energy metabolism was affected by environmental or ambient temperature as well as by the density and type of energy source in the feed. In a series of experiments (Soyaiya, 1988a,b; Sonaiya, Ristic and Kline, 1989), we demostrated that at high diurnal temperatures (30°C - 21°C), energy intake and deposition is better regulated in the male than in the female broilers. Physiological studies based on blood parameters indicated that male broilers fed higher energy diets at these high temperatures were protected from alkalosis while females were not so protected. Careful retention studies we carried out revealed that energy retention was higher at lower temperatures (21°C) and on higher energy diets. This is because at high temperatures, energy requirement for growth was much higher although maintenance requirements were lower. In simple terms, these results indicate that young animals, and children too, raised at high diurnal ambient temperatures would have grown faster had they been raised at lower temperatures. This indicates that the slow growth and smaller body sizes of tropical livestock have physiological and biochemical bases rather than a more ominous genetic basis. I have seen the famous West African Dwarf goats that are born in the experimental station of the Wageningen Agricultural University in the Netherlands grow much taller than the WAD goats born and raised here on our University Teaching and Research farm.

We also observed a significant interaction effect of dietary energy, ambient temperature, sex and age on the fatty acids composition of broiler abdominal fat. The polyunsaturated/saturated fatty acids (P/S) ratios was increased by low ambient temperature, high dietary energy, early slaughter point for female broilers significantly improves energy efficiency of production and hence, profit. The use of abdominal fat thickness as an indicator of total body fat in broilers as well as the use of liquid nitrogen in quantitative grinding of frozen meat samples to prevent fat smearing and loss during chemical analysis for retention studies are significant contributions we made to the methodology for research into energetics of growth and development in poultry.

ANIMAL PRODUCTION SYSTEMS, THE BRIDGE TO THE FARMERS

The methods of livestock production have been distinguished into three: Pastoral or Nomadic, Transhumant or Agropastoral, and Mixed farming or Settled. In terms of energy input into the production system, the direct classification into extensive, semi-intensive and intensive systems is preferred. Let me illustrate with the production of beef, the meat from cattle and the most popular edible animal product among Nigerians (Sonaiya, 1984b). The beef we eat is invariably from grass-fed, extensively-produced cattle. Conversely, in Europe and the USA, the norm is beef from intensively-produced cattle. Pastoral herds and intensive beef lots are the two extremes of a very long chain of varying levels of association between plant cropping and cattle production. In areas where domesticated animals have to move in response to the seasonal fluctuations feed resources, livestock rearing is not only extensive, it is non-sedentary at different levels. Where movements of animals is over very wide areas, pastroralism or transhumance is practised. When the animals roam over a smaller areas, pastroralism or transhumance is practised. When the animals roam over a smaller area such as the village and farmstead, it is called scavenging. At the other end of sedentary livestock rearing is the intensive beef lots found in areas close to centres of consumption and close to access roads and means of communication. For this industrial method of fattening, cattle are completely confined to their stalls and are fed high quality grain and silage in order to provide their energy requirement.

Agriculture, whether manual or mechanised, is an energy intensive enterprise. For mechanised agriculture in Nigeria, Adegbulugbe, Ibitoye and Akinbami (1996), estimated that irrigation pumps and tractors consumed 2,479 petajoules in 1995. Slash and burn crop technology requires few tools (cutlass and hoe) but lots of manual energy. For example, to raise one hectare of corn by slash and burn cultivation requires a total of 1,144 hours of labour equivalent to 2,699 megajoules (out of a total energy requirement of 2,828 megajoules) for a yield of 2,000 kg. In mechanised agriculture, the yield of corn per hectare is greatly increased to 5,000 kg. However, this two and a half fold increase in yield is accompanied by almost a twelve fold increase in energy consumption to 39,727 megajoules. To produce 1 kilojoule of beef, a total of 123 kilojoules of feed is consumed by the beef cattle. Milk protein is much more efficiently produced, requiring only 22 kilojoule of feed for each kilojoule of milk. Under good production conditions, a kilogram of chicken is regarded as 2.5 kg of maize and 1kg of groundnut. Now we know it to be equivalent ultimately to about 30 litres of petrol. Hence, the annual world chicken meat consumption, estimated at 37 million tons, is equivalent to 13.2 billion barrels of crude petroleum.

That there is a linear relationship between energy use and productivity is beyond dispute. Man has utilized fossil energy resources to increase food production for an increasing population. Industrial agriculture is based on the use of cheap sources of energy for power on the fields and processing units, and for the production of abundant supplies of nitrogen, other fertilizers, agricultural chemicals and other supplies. Indeed, fuel and electrical energy are essential inputs to industrial agriculture.

Energy, whether its price or supply, brings many problems of agricultural production into a more unified perspective. The disadvantage of this new perspective is that agricultural experts do not know for certain how to evaluate the energy factor because the paradigms ofindustrial agricultural production were developed when neither price nor supply of energy was of any great significance. On the other hand, the advantages of the unified perspective are that the energy problem makes the search for `low energy, intensive and sustainable agriculture' (LEISA) imperative. High energy costs and high food prices have joined forces with the environmental concerns to push us toward effective low energy, intensive and environmentally intelligent sustainable agriculture (L[E]$_2$SA).

An important characterisitc of LEISA is a greater number of jobs created and a broader economic base to provide adequate income for those jobs. American agricultural efficiency was, until very recently, measured in terms of how few farm workers are needed to supply food, fibre and other farm products. Consistent with the development of a highly energy-intensive agricultural system has been the exodus of rural populations to urban centres. As America is also demonstrating, far more jobs are created by service industries and small scale businesses, a category into which the production, processing, distribution and consumption of animal products neatly fall. As a young researcher in Animal Products, I asked anyone who would listen to explain who I was working for; who my clients were. The large-scale intensive animal products farms did not show much interest in what seemed to me perfectly results on broiler growth and development and its effect on slaughter point determination. I started to look for a way to remove the asynchrony between research, extension and commercial operations in animal products supply. This search led me to the study of extensive rural poultry production systems.

The approach, procedure and methodologies for the study of extensive small holder rural poultry production systems differ greatly from those of our earlier interest. To make up for lack of a significant body of literature on the topic, social science methods for acquiring information directly from people had to be used. Participatory methods i.e. questionnaire surveys and rapid rural appraisal, as well as methods for agroecological evaluation were needed to establish the structure and significance of poultry production in the rural economy. In 1989, the FAO asked me to organise an intenational workshop on rural poultry development research in Africa. This workshop, and its proceedings -"Rural Poultry in Africa" - which I edited, made available a mine of unpublished data about breeds, housing, health, feeding, management and marketing of rural poultry in Africa.

From a detailed review of this emergent literature, I (Sonaiya, 1990$_e$, f) surmised that Newcastle disease was the first priority problem, that right shelter was absolutely necessary, that interventions in brooding up to 4 weeks, and in energy feed supplementation were required in order to improve productivity of rural poultry. Using equipment grants from the Alexander von Humboldt-Stiftung (Germany) and research grants from the International Foundation for Science (Sweden) and the International Development Research Centre (Canada), we set out to study in as much detail as we could, every facet of the rural poultry production system.

Rural Poultry Research and Development

Rural poultry development is not a new thing. Development efforts in Nigeria date as far back as 1919 (Sonaiya, 1989d). various schemes have been executed but the approach in most of these schemes had been toward genetic improvement and/or vaccination. The most widespread strategy was the cockerel exchange programme or *Operation Coq* as it si called in Francophone countries. Wherever genetic improvement strategies have been combined with either vaccination, feeding and housing improvement or farmers training, better success had been achieved.

Development of rural poultry production can contribute significantly to rural development by improving family nutrition and incomes, employment opportunities and promoting equity for women. Rural poultry development has been found to be ideal for rehabilitation of refugees and victims of disasters and wars. Somali nomads who lost most of their cattle to droughts accepted poultry and its products as substitutes for cattle and beef, respectively. Widows of the Ugandan civil war were rehabilitated by the Catholic Church of Uganda through a rural poultry programme initiated in 1987

Before our efforts, reseach into village poultry production in Nigeria was negligible; far less than the importance of the sector. The 1992 livestock population census showed that of the 114 million poultry, 104 million were held in the rural areas. All classes of poultry are raised in the villages: chickens, ducks, geese, guinea fowls, pigeons and turkeys. In the forest zones, flock composition is heavily skewed towards chickens while guinea fowls are more important in the savanna and sahel zones. About 72% and 70% of rural poultry producers in the north-west keep turkeys and ducks, respectively (Sonaiya, 1990a). These rural poultry make the greatest contribution to the supply of meat and eggs for the average Nigerian. For example, annually, about 89% of total poultry meat consumed and over 25% of total poultry eggs consumed come from rural flocks. Research and development work that will increase productivity of rural poultry by 10% will contribute far more poultry products than huge investments in industrial poulry that will lead to a 10% increase in poultry-housed production. In order to solve the problems of rural poultry such as high mortality,low productivity and seasonal supply of products, it is necessary to develop cost-effective improvements for application at the village level. This was the guiding principle for our rural poultry work.

A Rural Poultry Research Project (RPRP) was conceived in 1987. The objective was to study the whole system of traditional poultry production and to develop practical interventions for enhancing the productivity, efficiency and profitability of the village flocks. The initial phase was series of field surveys of traditional poultry management in villages located in 10 states of the Federation - Delta, Edo, Ekiti, Kano, Kwara, Lagos, Ogun, Ondo, Osun and Oyo - at different times. The survey teams for most states were multidisciplinary in nature and comprised at different times, Prof. Oluyemi, Department of Animal Science, University of Ibadan; Dr. Mrs Matanmi, Dr. Mrs Daniyan, Dr. Odubote, Mr. Olori, Mr. Akinlade and Mr. Omoseibi of our department; Dr. Laogun and Dr. Miss Akande of the department of Agricultural Extention; Dr. Oguntade and Dr. Idowu of the department of

Agricultural Economics of our Faculty.

These surveys revealed that the average flock size was about 20 birds with a male to female ratio ranging from 1:1 to 2:3 and the larger the flock size, the more males there were. The classes of poultry kept by villagers were chickens, ducks and pigeons in the south; chickens, ducks, guinea fowls, turkeys and pigeons in the north. Exotic and native chickens were kept including a strain obtained only from the migratory Fulani pastoralists which is bigger and grows faster than the non-Fulani chickens. the common `duck' in Nigeria is the black and white Muscovy *(Çairina moschata)* which is not a duck at all as it belongs to the family of geese. The common guinea fowl (the only poultry species indigenous to Africa) is the grey helmeted *Numida meleagris*. Chicken mature weight, achieved at about 56 weeks, ranged from 1.0 to 2.5 kg. Each year, hens laid eggs in 3-4 clutches with 5-15 eggs per clutch. Hatchability is very high due mostly to predators, disease, car accidents and floods. The birds scavenge for insects, earthworms, maggots, green leaves and stone grits, and are supplemented with grains (maize and sorghum) 3 times daily. Major outbreaks of Newcastle disease regularly occur at the peak of the rains (June/July) and the dry season (January/February) during which mortality reaches 70-100%. Farmers reported that prevention of Newcastle disease was possible when birds drink a water extract of a local pumpkin (*`Tagiiri' - Lagenaria breviflora*) mixed with pepper (`Ata wewe - Capsicum frutescens).

All rural poultry depend on human habitation for their feed and the ratio of poultry to the farming population is usually about 1:1.3. Free range birds do not receive regular feeding but survive through scavenging around the village. Energy is the first limiting nutrient as the food available on the range contains a lot of crude fibre. One way to increase energy supply for egg production is to provide grain suplements in the morning and evening as most eggs are laid in the evening and morning. Obi and Sonaiya (1995) reported that their village respondents gave to each bird daily, an average of 19g of maize and 11g of sorghum supplements. A very important factor in relation to feed consumption and efficiency is water consumption. In subhumid and humid zones, 25-40% of smallholders do not specifically offer water to free range birds.

We have been able to follow up virtually every facet of this fascinating system - genetics andbreeding, health care, feeds and feeding, housing and management, marketing, production economics and extension methods. To support this project, a brand new Poultry Meat Reseach Laboratory was developed withfunds from the International Foundation for Science, the Alexander von Humboldt Foundation and the European Commission and equipped to study poultry from the egg to the table.

The varieties of chicken reared in the villages are usually differentiated by feather colour and other external characteristics. Some, however, are reported (Sonaiya, 1990e) to possess genes which affect adaptability and productivity in hot climates. Examples are the genes for featherless neck (Abolorun in Yoruba or Pingi in Hausa), dwarf body type (Arupe or Durugu) and frizzled feather (Asa or Shazumama). Victor Olori (1992) evaluated the chickens owned by the cattle Fulani and compard them with the chickens of Non-Fulani people and showed that there was a genetic basis for the superiority of the Fulani birds which we later found are supplied to other Fulani groups by the Bororo from inbred closed nucleus flocks that have been selected for meat productin and hardiness. From on-farm and on-station research, Olubunmi Idowu (1992) showed that unconventional feedstuffs such as fermented maize residue (eeri from making ogi), cowpea testa (discarded during making akara and moin-moin) and palm oil sludge (obtained from the eku where palm oil is traditionally extracted) can form the basis of a supplementary ration for scavenging chickens. Sonaiya (1993b) reported the use of these unconventional feedstuffs as a supplement for scavenging chicken in an unbalanced ration containing 110g protein and 15MJ metabolizable energy per kg feed. Supplementation intake as low as 8g/day increased the body weight gain of scavenging grower chickens.

Generally, productivity of birds increases directly with the level of managements. Under the free range and backyard systems, egg production per hen per year is 30-40 for ducts, 60-80 for turkeys, 30-100 for chickens and 100-120 for guinea fowl. The guinea fowl is an exception for while it supplies 53% of total poultry eggs traded and consumed in rural areas, its eggs are merely gathered from the free range. Hatchability of poultry eggs is consistently about 80% in all regions of Nigeria but mortality is at least 50% and average daily gain is about 6g for grower chicks and keets.

Many diseases plague rural poultry including Gumboro, coccidiosis, fowl pox, fowl typhoid, fowl cholera and external parasites like lice and mites. Newcastle disease is the most important disease causing very high mortality. Vaccination of rural birds against Nescastle disease is an obvious priority. With Olutayo Obi (1995), we conducted on-farm studies on the effect of vaccination against Newcastle disease and of feed supplementation on the productivity of scavenging village chickens. The results indicated a significant increase in growth rate, egg productin and chick survival.

In order to disseminate this new knowledge coming from us and from all over Africa, we initiated in 1989, at the workshop held here at Ile-Ife, the African Network for Rural Poultry Development (ANRPD). This is an independent voluntary association targeted at researchers, policy makers, educationists, development agencies (including NGOs) and smallholder farmers operating in or interested in Africa. By 1995, there were 306 members from 34 African, 9 European, 3 Asian, 2 South Pacific, 2 South American and 2 North American countries. Two international organisation - the Food and Agriculture organisation of the United Nations (FAO) and the European Community's African, Caribbean and Pacific's Technical Centre for Agricultural and Rural Cooperation (CTA) - have shown paticular interest in the Network since its formation. The Network publishes a Newsletter in English and French two times a year and a Directory of Rural Poultry in Africa once a year. Every two years, there is a meeting in December 1997 at M\Bour via Dakar, Senegal, it was decided to widen the scope and coverage of the Network which was renamed the Internatinal Network for Family Poultry Development (INFPD) and its Newsletter is now published on the Internet and our next méeting will be held during the World Poultry Congress 2000 in Montreal, Canada. I have had the privilege to serve as the Coordinator of the ANRPD and now INFPD for the last ten years and as editor of its newsletter and the published proceedings of its international conferences.

Between 1992 and 1997, we participated in a cooperative research project funded by the European Commission's Science and Technology Development Programme. The cooperating institutions and scientists were: Prince Leopold Institute of Tropical Medicine, Belgium - Dr. Ir. F. Demey and Ing. R. Baelmans; Unversidad Tecnica de Oruro, Bolivia - Ing. O. Iniguez; Humboldt University of Berlin, Germany - Prof. Dr. P. Horst, Prof. Dr. Anne Valle Zarate, Dr. P.K. Mathur and Dr. K. Wimmers; Central Avian Research Institute, India - Dr. D.P. Singh; and Obafemi Awolowo University, Nigeria - Prof. E.B. Sonaiya and Dr. I.K. Odubote. Overall coordination and leadership was provided by the most distinguished and most experienced Prof. Peter Horst of Germany. Our particular objective in Nigeria, within the larger project objective, was to evaluate how local poultry populations vary in their ability to produce and to resist diseases. A total of 28 populations (1,570 locals and 1,192 exotics) were evaluated, on the University Teaching and Research Farm, for physical appearance and production performance. We also searched for genetic differences between collections from ecological zones in Nigeria - Kaduna and Jos from the Guinea savanna; Makurdi and Ilorin from the Derived savanna; and Nsukka and Sagamu from the rain forest zones.

Our results (Sonaiya et al, 1995) showed that our local chickens are superior in disease resistance to the exotic Rhode Island Red chickens. Disease resistance or immune competence was determined by our Belgian partners using sheep red blood cell and phytohemaglutinin to examine the humoral and cellular immunity and complement activity. Our German partners carried out polymerase chain reaction (PCR) genotyping using 22 polymorphic microsatellite loci from the samples we took and prepared for DNA analysis. Heterozygosity, Nei's distance and allele sharing were used to measure genetic variation and similarity, respectively. These methods grouped the Nigerian local chicken ecotypes together with the Rhode Island Red while the local chickens from Bolivia, India and Tanzania were distinct from the Rhode Island Red. This is an indication that there has been a great deal of gene mixing between the Nigerian local and the Euro-American commercial lines as we previously suggested (Sonaiya, 1989d; 1996b). Nonetheless, the Nigerian collections showed a higher mean heterozygosity than the Rhode Island Red. Although the collections from the different ecozones did not differ sufficiently from each other to qualify as separate strains, there are indications of adaptations to the ecoregions which may be explored by inbreeding and selection in order to develop Nigerian poultry breeds for different purposes.

In order to apply the results of this research, we are continuing to further evaluate the hens of the Nigerian chickens and their crosses with Rhode Island Red for egg laying performance and persistency and feed efficiency. The egg production, egg weight and feed efficiency will be related to income from a layer enterprise. The cocks will be distributed to smallholder poultry producers and the survival and breeding performance of these cocks will be monitored. In a pilot study we conducted with smallholders here on campus, we found indications that the size of the cock determined its opportunity to mate with the local hens on the free range. In cooperation with the Songhai Centre in Porto Novo, Benin Republic, (a non-governmental organization for training, research and development in $L[E]_2SA$, rural empowerment and philosophy of development whose Director, Father Geoffrey Nzamujo, O.P., shared with President Jerry Rawlings of Ghana the 1993 Africa Prize for the fight against World Hunger) we have been studying the performance of the first and second generations of Rhode Island Red birds. The results so far indicate very good hatchability of the eggs and impressive growth performance of the chickens.

The crosses between Nigerian locals and Rhode Island Red were backcrossed to their parents. All chicks hatched were tested on-station and the pullets and cockerels distributed for on-farm testing. The line with the best adaptation to the smallholder poultry situation can be multiplied and distributed to research stations and farmers throughout the country. It is hoped that the improvement in performnace will result in increased incomes from extensive poultry production. This phase of applied research will continue to involve our students (undergraduate and graduate) as well as research and extension personnel from other institutions as well as farmers.

HYPOTHESES, THE BRIDGE BETWEEN ANIMAL SCIENTISTS

Sustainable development is the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable (FAO, 1989). Livestock strategies must be judged according to their likely impact on economic, ecological, ethological and sociological issues (Preston and Murgueitio, 1992). Ecological sustainability requires that the production system will result in:

(i) the reduction of the principal greenhouse gases - CO_2, CH_4

(ii) reduced contamination of soil and water resources;

(iii) an effective control of soil erosion; and

(iv) on-farm production of energy from renewable resources.

Ethological concerns relate to potential effects of production systems on animal welfare and the safety and consumer acceptability (wholesomeness) of the foods produced in such systems. Sociological issues require that employment opportunities are increased.

Strategies for sustainable livestock production must aim at an increased integration between crops and livestock production. The strategies will also involve a change in cropping pattern through the selection of crops which will maximise biomass production and nitrogen fixation with minimum imported inputs. They must match the competition for labour for livestock and crop production by the introduction or intensification of draught animal power. Another part of the strategies should be the useof multipurpose animals that provide draught animal power, milk and meat, and the introduction into the production systems of small and non-ruminant species that are well adapted to the forage resources, by-products and wastes produced by the farms.

This question of sustainability is likely to engage my research and teaching efforts for the coming years by the grace of God. How can animal products be obtained in a sustainable way, in a way that benefits more directly other agricultural enterprises such as crops (annual and permanent), fish and foresty?

Consider the debate between those that pin their hopes for livestock development on the transfer of the most advanced technology and those that rely on modification of traditional technology to make them more appropriate and more likely to create employment rather than capital. The technology transfer group says that what adds to social well-being is the volume of goods produced, not the number of jobs created, i.e., what is important is to produce more food, not how it is produced or who produces it. This position, which has enjoyed the pride of place up to date, seeks to replace traditional livestock systems with "modern" ones. The failure of our "modern" poultry industry indicates the inadequacy of this option.

The better option is that of technological blending, defined as the integration of newly emerging technologies with traditional modes of production to ensure higher productivity. This is exemplified in the United States and Europe by "precision agriculture," the use of advanced technology to increase yields and reduce environmental impact. In industrial farming, a cultivated field is regarded as a single tract of land, and pesticides, herbicides and fertilizers are uniformly dispersed across the entire area. But each field can vary widely in terms of soil chemsitry and weed concentration. One section might be infested with weeds, for example, and need heavy doses of herbicides, while another might be naturally weed-free. Precision agriculture enables farmers to tailor their use of chemicals to the requirements of small patches of soil, sometimes even on the scale of individual plants. As a result, the use of agrochemicals - and the ecological damage they cause - can be reduced. In animal production, such an approach can include, for example, computer control of biogas production from manure; computer control of grazing or scavenging by animals on the range; and development of transgenic poultry that can digest high fibre diets. In any case there is no alternative to a thorough understanding of traditional peoples and their indigenous technology. The spread of scientific practices and methods starts first with the spread of a technical culture. This means that scientists and technologists must go to the villages to measure, weigh and observe along with the farmers.

In order to initiate this technological blending, we must pay attention to our institutions and procedures for training, research and extension. The training of manpower for agricultural development must not only be multidisciplinary (which it is) but must emphasise theblending ofdisciplines, of science and tradition, ofold and emerging technologies. Such a training must be led by relevant and appropriate research. The 16 Faculties of Agriculture and 3 Universities of Agriculture must continue to engage in relevant teaching, reseach and extension by reappraising their programmes in relation to sustainability, energetic efficiency and environmental awareness.

CONCLUSION AND RECOMMENDATIONS

Most of our livestock are held in small rural farms. Their development by blending new technology with traditional methods can contribute significantly to the generation of rural employment and expansion of food production. Such a development requires skills, perspectives and orientation often not included in the academic training of agricultural research scientists, including communication, community development, qualitative research, farming system analysis, gender analysis, design and management of on-farm trials, and participatory monitoring and evaluation. How can we equip mature research scientists with these skills so that they can have enough confidence to apply them?

Agricultural research serves a wide range of clients, not only low-income farmers, or farmers in general, but also processing industries,other scientists, and government ministries and parastatals. With all types of clients, the key dialogue is between what `science' has to offer and what clients require. How can we get the farmers to participate in setting research agenda and goals? Farmers in the middle and higher income ranges participate through the market by hiring consultants or by exerting pressure through lobby groups or by vocal response to the technologies on display during visits to research stations. Low-income farmers are less likely to participate either via market or by making vocal demands; their farming systems are difficult to replicate on research stations. Effort is required by researchers to understand these systems and to experiment on-farm with farmers. Attitudinal changes are required at the institutional level in the following areas:

- A committment to producing results of use for an identified set of clients'
- Performance criteria, the means of assessing work against these criteria, and the types of reward and incentives provided must all be geared to success in delivering technologies to meet clients' needs;
- Scientists need specific training in the methods of participating with farmers.

In order to identify appropriate technologies that will improve the performance of locally available animal and feed resources, there is a need for further adaptive research and development effort to put in context prevalent ideas and technology. Such adaptive efforts require a multi-disciplinary collaboration as can be found in a flexible programme structure rather than rigid departmentalization. The identification of beneficiaries in all research project proposals submitted for funding should become a standard requirement.

Barely 18 months to the beginning of the 21st Century, the challenges that face and will continue to face agriculture are related to energy supply; use and efficiency, environmental consideration and their impact on economic sustainability. I propose the organization of an Annual Conference on Environment, Energy and Sustainable Agriculture. This conference will provide a yearly forum for the examination and reevaluation of policies, strategies and technological developments in these areas which are vital to the survival and development of the Federal Republic of Nigeria in the 21st Century.

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