AN INTRODUCTION TO ANIMAL PRODUCTION:
Ruminant Production

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SCHOOL OF VETERINARY MEDICINE
UWI
MOUNT HOPE

MODULE 2:
AN INTRODUCTION TO RUMINANT PRODUCTION SYSTEMS

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MODULE 2 – INTRODUCTION **3**

2.0 INTRODUCTION **3**
MODULE 2: LEARNING OBJECTIVES **3**
2.1. LIVESTOCK PRODUCTION SYSTEMS IN THE CARIBBEAN 3
2.1.1. An Overview of Livestock Production in the CARICOM Region 3
2.1.2. Importance of ruminants to our economies and to mankind 5
2.1.3. Non-Ruminant Livestock Production 5
2.1.4. Types of Livestock Production Systems 7
2.1.5. Features of the Tropics Influencing Livestock Products 8
and Products of Animal Origin 8
INTENSIVE LIVESTOCK PRODUCTION MODELLING/APPROACHES AT DEVELOPING ANIMAL PRODUCTION SYSTEMS **11**
2.2 AN INTRODUCTION TO INTENSIVE LIVESTOCK PRODUCTION MODELLING 11
2.2.1. What is " a" or " the" Physiological State of an animal? 13
2.2.2. The effect of the Factors Affecting Animal Production on Wild Animals Reared in Captivity: 14
In the wild the animals live within a habitat. In this habitat 14
2.2.3. Intensive Animal Production Systems: 14
Intensification 14
Features of intensification 14
The Implications of Intensification on Production 15
2.2.4. The Role of Housing and Equipment under intensive systems of production 15
Key elements of livestock housing under intensive conditions 16
2.2.5 APPROACHES TO DEVELOPING ANIMAL PRODUCTION SYSTEMS/ CONCEPTS IN DEVELOPING INTENSIVE ANIMAL SPECIES PRODUCTION MODELING 16
2.2.5.1. Considerations for species production modelling 17
2.3. WILDLIFE FARMING 20
2.3.1. RATIONALE BEHIND INTENSIVE / SEMI-INTENSIVE WILDLIFE PRODUCTION / FARMING: 20
2.3.2. The Evolution of Wildlife Farming in Trinidad & Tobago 20
2.3.3. The role of wildlife farming: 22

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Module 2 – INTRODUCTION

By: Gary Wayne Garcia [Senior Lecturer in Animal Production]

2.0 INTRODUCTION

Module 2: Learning Objectives

This unit seeks to give you:

1. a brief understanding of Livestock Production Systems in the Caribbean and
2. to outline for you the concept of intensive livestock production modelling.

So far in years 1&2 of VM110 you covered **Animal Handling and Restraint**; some **Farm Management Principles**, **Animal Nutrition** and an **Introduction to Animal Breeding and Genetics**.

In year 2 Semester II you would be further introduced An Introduction to Ruminant Production [Production of Small Ruminants (Sheep and Goats); and Dairy and Beef Production] and Wildlife Management.

2.1. Livestock Production Systems in the Caribbean

2.1.1. An Overview of Livestock Production in the CARICOM Region

In the Caribbean swine and poultry production have become very well developed over the last 20 years. On the other hand, the production of ruminants and the products of ruminants remain largely underdeveloped. It is also to be noted that CARICOM countries and most tropical developing countries are net importers of food and products of animal origin. Fish and fish products are also imported despite the abundance of fish life in the Caribbean marine environment. The animal products of major nutritional importance to human beings are: milk (from dairy cattle, buffaloes, goats and sheep); eggs (from the modern breeds of poultry); fish and seafood (mainly as sources of protein which are harvested from the sea) and animal fat (from poultry, pork and beef).

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Ruminants offer a good possibility for expansion of the food production efforts, but this sub-sector's low state of development particularly in the Caribbean [with the exception of Jamaica], has been partially attributed to:
a) the sub-sector's inability to compete with the developed countries' commercial forces,
b) changes in technology and
c) a lack of improved managerial abilities (both within the commercial sector and the Governments' decision making infrastructure).

This lack of development on the part of the ruminant livestock sub-sector in CARICOM, has costly foreign exchange implications, which seriously threatens the region's food security. The total cost of the imports of all animal products and the inputs for local animal production, continues to constitute more than 50% of the regions' more than **1 billion US$ annual food import bill.** This food is required for feeding the regions' 5 to 6 million people (CARICOM). The apparent lack of development of the region's livestock sub-sector, possibly lies in the fact that the Caribbean Community has had a common history of **the production of crops for export with corresponding importation to satisfy food requirements.** Until the last few decades, most of the agricultural research efforts were directed towards the production of these traditional export crops. Consistent efforts leading to the successful development of a major livestock production industry has not been applied, except in the case of Jamaica and to a lesser extent Trinidad and Tobago, Barbados and Guyana. Earnings from the export of crops and recently from the Tourism and Mineral Extraction Industries have been used to finance the **food imports**. Present economic conditions and those which existed over the last decade have now demanded that this situation be changed. In this setting, **RUMINANT PRODUCTION** should be encouraged since:
1) there has been a tradition of low input small ruminant (sheep and goat) production;
2) ruminants can utilise crop residues and other fibrous products which man cannot digest; and
3) imported ruminant products are a major foreign exchange user.

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2.1.2. Importance of ruminants to our economies and to mankind

This importance can be highlighted as follows:
- ruminants convert Fibre and Structural Carbohydrates, indigestible by man and monogastrics, into food and useful animal products;
- these they produce from crop residues and from waste of uncropped areas;
- they convert agro-industrial by-products which are normally considered wastes, into food or useful animal products;
- they are able to convert inorganic N [in the form of non-protein-nitrogen **(NPN)**] into animal protein;
- ruminant animal waste can be used:
  i. as a source of fuel or energy e.g. dried manure or for the generation of biogas; and
  ii. as a source of organic fertiliser for food crop production;
- they provide draft, transportation or power.

2.1.3. Non-Ruminant Livestock Production

In general, non-ruminants do not digest fibre to the same extent as do ruminants. Therefore, theoretically, they compete with humans for food. In the Caribbean swine and poultry production have become very well developed over the last 20 years. Rabbit production on the other hand, is still relegated to the status of being a backyard hobby, and fish are simply harvested from the sea with few direct efforts at inland fish production (with some exception in Trinidad, Guyana, Puerto Rico and Jamaica). The production and processing of Poultry and Pork products make an important contribution to the protein needs of the region, though this is mostly achieved through the importation of eggs for the production of broilers, and grain and feed additives for the blending of formulated animal feeds. This results in a significant demand for foreign exchange.

The Poultry Industry

The poultry industry is characterised by its **high degree of Vertical Integration as follows:**
1.Grain Terminal to store the imported feeds -> **2.**Feed Miller-> **3.** Feed Distributor -> **4.** Egg Importer / Hatchery-> **5.** Contract Processor -> **6.**

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Contract Farmers-> **7.** Fast Food Outlets ; Pluck Shops and Supermarket Chains.

In Trinidad there has been the recent development of a Broiler-Breeder operation (**The National Poultry Company which has been recently privatised)** however this has been done through the initiative of the state. This would negate the need to import the eggs for hatching into broilers. **This operation is, however, the aspect of poultry production which is the most risky and the least profitable, but which requires the highest standards of animal and enterprise management.** In Trinidad and Tobago, as within the rest of CARICOM, poultry is seldom processed into products other than those for immediate meat consumption. Jamaica, however, has the best developed Poultry Industry, with Jamaica Broilers Limited being the leader in Poultry production in the Caricom region. In the Caribbean the Poultry industry is the most technologically developed and financially successful agricultural sub-sector, with Jamaica, Trinidad and Tobago and Barbados taking the lead respectively. Self-sufficiency in poultry products (table eggs and broiler chicken meat) in the Caribbean region ranges between 71-95%, with Jamaica taking the lead.

The Pig Industry

This industry is characterised by **some degree of vertical integration,** but not as much as that which exists for the poultry industry. Some large production units are owned and operated by people with major interests in processing facilities. The situation can be described as follows:

1]. Large Farms-> Processing and Feed Mixing Facilities;
2]. Large Farms -> Wholesale hogs to the most convenient buyers, and purchase feed from millers;
3]. Small Farms-> Sell mainly to the fresh meat market and purchase feeds;
4]. Back yard producer-> Produces for the fresh meat trade, for special events and for extra income.

In Trinidad and Tobago there are only three (3) large companies in category 1 above.

The Rabbit Industry

The Department of Food Production of the UWI and The Ministry of Food Production have embarked on the development of units for Rabbit rearing. There is a small rabbit unit at the University Field Station and some small

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rabbit units exist throughout Trinidad and Tobago. However, this industry is still in its embryonic stages. The 4H movement has also been active in promoting rabbit rearing. In the French speaking Caribbean (Martinique and Guadeloupe), rabbit rearing is much more developed, to the extent where rabbit meat can be purchased at supermarkets year-round, and rabbit dishes are served at restaurants.

The Fish Industry

In almost all of the CARICOM and the other Caribbean countries, the fish industry is made up of many small fishermen who own and operate one or a few small boats, and who operate alongside large fleet owners. These fleet owners are either within the private or the public sector. The most striking feature of this livestock industry however is that it is based on **chance** harvesting from the sea with limited processing. A high degree of wastage is therefore present and almost no efforts are made at monitoring the natural fish populations, or at attempting to sustain existing populations. Yet fish has been, and continues to be, one of the major sources of animal protein in our diets.

2.1.4. Types of Livestock Production Systems

The types of livestock production systems can be generally classified as being Extensive, Intensive and Semi-Intensive.

Extensive Systems:

A. Subsistence or Semi- Subsistence
- -Pastoralism
- -Crop agriculture with extensive cattle or sheep production
- -Fishing: the harvesting of fish from the sea

B. Commercial
- -Ranching of Cattle, Sheep, Goats

The Extensive systems are characterised by the use of vast expanses of land or sea (as in the case of marine fishing), which must be easily and cheaply available; a low animal to land ratio; low levels of technical and managerial inputs; minimum cash outlays, which may be used only to procure harvesting facilities and equipment; minimum labour demands; and a product output and product quality which may be variable.

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Intensive Systems:

A. Commercial

Rotational Dairy and Beef Cattle - forage crop production
Integrated Dairy and Beef Cattle- perennial crop production
Modern sector Dairy and Beef Cattle production
Modern sector poultry and Pig Production
Inland Aquaculture Production

The Intensive systems are characterised by: the use of relatively limited amounts of well-developed land, which must be well supplied with potable water and electrical power; a high animal to land ratio; high levels of technical and managerial inputs; high levels of cash outlays; exacting labour demands; and a product output and quality which must be well-defined to suit specific and high volume markets.

Semi- Intensive Systems:

A. Semi-Subsistence or Semi- Commercial

Sedentary crop agriculture with cattle or ruminant production

These systems lie between the two extremes defined above.

2.1.5. Features of the Tropics Influencing Livestock Products and Products of Animal Origin

The Tropics Defined:

This is the area of the world between the Tropic of Cancer 23.5^{o} N Latitude

and the Tropic of Capricorn 23.5^{o} S Latitude.

The Diversity of the Tropical Environment:

The tropical environment is very diverse, as reflected by the six major climatic groups enumerated below.

- Humid Tropics
- High Altitude Tropics
- Monsoon Tropics
- Wet and Dry Tropics
- Arid Tropics

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- Semi-Arid Tropics

The Caribbean lies basically in the Wet and Dry Tropics generally characterised by six rainy months and six dry months . However, pockets of the Humid Tropics and Semi- Arid Tropics exists, Guyana, North East Trinidad, Central Guadeloupe, Central Puerto Rico, and the Blue Mountains of Jamaica represent areas of the humid tropics. Antigua and Nevis represent areas of the Semi-Arid Tropics.

Climatic factors of prime importance to agriculture and animal production in the Tropics:

- Temperature
  - annual range
  - daily range
- Rainfall
  - Monthly distribution
  - Annual distribution
  - Intensity of Rainfall
- Relative humidity
- Air and wind movements
- Solar Radiation

Physical factors of prime importance to agriculture and animal production in the Tropics:

- Distance from the sea
- Direction of prevailing winds
- Altitude
- Soil Parent material
- Nature of the sub-soil

Some socio-economic considerations of relevance to the Tropics:

1) Duality of production:

- crop vs livestock with the production of large and small ruminants being the least organised generally;

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2) Some degree of infrastructural development:

3) Production tends to be traditional;

4) Limited grading and the absence of widespread structured livestock marketing systems:

-marketing and grading systems for ruminants and ruminant products are not well developed and generally the ruminant and livestock producers are price takers;

5) Equipment and inputs are high priced, and are usually imported;

6) Limited livestock processing exists:

7) Low per capita levels of consumption of livestock products:

-where the levels are high it is usually as a result of high imports;

8) Religious taboos:

- these affect the consumption of livestock products from one place to another and from product to product;

9) Plantation Economies:

- tropical countries generally show low levels of widespread development with the economies being PLANTATION MODEL ECONOMIES (Best-Beckford Model)
- the NEW WORLD ECONOMIC ORDER and the OPENING UP of WORLD ECONOMIES are threatening further to exacebate the low productivity and competitive state of the Tropical Third World Economies.

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Intensive Livestock Production Modelling/Approaches at Developing Animal Production Systems

2.2 An Introduction to Intensive Livestock Production Modelling

Now that we have presented you with an overview of the nature and state of Livestock Production within the Caribbean, we would now like to outline for you the philosophical basis used in approaching or developing intensive animal production systems. This approach is based on two pillars and these are:

1] an understanding of **the factors affecting animal production** and
2] **the physiological states of the animal species in question**.

What you would need to note at this point is that there is an interaction between the above two; and this interrelationship will determine the nature of the production system. The reason for this is that at each physiological state the effect of each factor is different
OR <u>the needs of</u> and <u>the threats to</u> the animals' survival will be different.

We would then proceed to discuss the items under each of the objectives outlined.

There are five (5) factors affecting the production of any animal species. They are:

1) Breeding and Reproduction,
2) Health and Disease,
3) Nutrition and Feeding,
4) Housing and Environment: Comfort needs and
5) Economic and Socio-economic.

The factors affecting livestock production can be further simplified as follows:

1. **Genetic [Breeding and Reproduction System]**

2. **Health [Disease Prevention and Management System]**

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3. **Nutrition [The Diets which are put into a Feeding System]**

4. **Environment [The housing and Animal Welfare System]**
   - Climatic Factors
     - Humidity
     - Temperature
     - Light
     - Wind
     - Rainfall
   - Soil Factors
     - Chemical Composition, pH, OM etc
   - Moisture Extremes
   - Altitude
   - Topography

5. **Economic and Marketing [The Animal Products Harvesting and Marketing System]**
   - Cost and availability of Land
   - Cost of animal inputs
   - Cost of non animal inputs
   - Market price of the Products Produced.

The first three factors can be easily controlled or improved through scientific research and improved management at the farm level. The fourth factor is god given, but science and management could be used to help the animals perform and produce efficiently within the given environment. <u>The fifth factor, however, is the one which determines the profitability and ultimately the economic sustainability of the production system. This however is not under the direct control of the farmers or producers.</u>

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2.2.1. What is " a" or " the" Physiological State of an animal?

Before we attempt a definition it is essential that we first put **the** animal in question into perspective. We shall first need to know the following about the animal:
- the species
- its' sex
- is it in early growth?
- is it in late growth?
- is it undergoing puberty [the changes necessary for going into the reproductive phase of life] ?
- is the animal being prepared for reproduction?
- what is its' reproductive state?
- what is its' productive state (or growth state or desired growth rate)?
- is it a working animal and what type of work is it doing ?
- what is the weight of the animal?

The physiological state of an animal can be seen therefore as a description of an individual animal or similar animals within a species, from the standpoint of their stage in their life cycle or productive state. This would then indicate to the animal manager or production facility developer what **the** animals' needs would be for :
- Nutrients
- Housing and Environmental comfort
- Disease prevention
- Reproductive management and
- Harvesting and Marketing the animal products.

Why would the nutrient needs of animals change at different physiological states?

Activity 2.1: Reading 2.1

Wood, A.; Garcia, G. W. and Osuji, P. O. (1983):
"Relevant feeding systems for beef and milk production in the Caribbean".
In: *Feeding of Animals in the Caribbean* (Proceedings of a Workshop sponsored jointly by CARDI and SFC - April 11-16, 1983) edited by F. Neckles, W. Cateau, and D. Walmsley. UWI Faculty of Agriculture, St. Augustine, Trinidad & Tobago. pp. 73-81

When you have finished this reading you can continue.

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Each physiological state of an animal creates different types of demands for the animals' comfort, well-being, and productive capability. This is in response to the animals' immediate needs for maintenance, growth, production (eggs, milk, plumage), work and reproduction.

2.2.2. The effect of the Factors Affecting Animal Production on Wild Animals Reared in Captivity:

In the wild the animals live within a habitat. In this habitat
- they have a place to live and are kept comfortable **(housing)** ,
- they get their food **(nutrition and feeding)** ,
- they are able to make their nests or reproduction sites for caring for their young and they are able to locate suitable mates **(breeding and reproduction)** and
- they are free to move within their habitat and are able to avoid diseases and predation **(disease prevention and control)**.

Therefore when wild animals are kept in captivity all of the above have to be provided, so that the keeper of these captive animals now has to ensure that all the functions performed by the habitat will now be provided for within the new captive environment.

2.2.3. Intensive Animal Production Systems:

We would now like to turn your attention to the concept and practice of intensification and it requirements and consequences.

Intensification
This involves the bringing together of many animals in a single location or in close proximity to each other with consequent problems due to increasing animal population densities.
Features of intensification
- use of limited land
- high animal to land ratio
- high levels of technical and managerial inputs are required
- variable quantities of capital outlays are required
- very labour demanding or may need forms of automation

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- expected product output required.

The Implications of Intensification on Production
- Animals have to be fed and watered with timely waste removal.
- Preventive techniques have to be instituted to avoid introduction and rapid spread of diseases.
- Animals' social behaviour need to be considered and provisions made for the animal social needs to be met.
- The design of the housing plays a key role in facilitating all of the above.

2.2.4. The Role of Housing and Equipment under intensive systems of production

The role or housing and equipment under intensive systems of production are as follows:

1] to protect the animal from the environment and predators;
2] to ensure the timely and controlled supply of feed nutrients and water;
3] to exclude disease causing organisms and to eliminate or minimise the possibility of and spread of diseases;
4] to protect the animals from trauma;
5] to protect man and to facilitate the ease of handling of animals through:
   a) special features and considerations for handling , restraint and treatment of animals,
   b) having the animals arranged into different physiological states;
6] to facilitate timely and efficient removal of waste;
7] to enable the grouping of animals into manageable units which could make the easy observation of animals individually;
8] to enable the easy handling of animals for either product collection (e.g. eggs) and or the sorting of animals for marketing;
9] to modify the environment to alleviate any stress which would be constraints to productivity; and
10] to provide specialist type of equipment to facilitate slaughter and processing.

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Key elements of livestock housing under intensive conditions

1] Water Supply
- Source
- availability
- method of transport
  - -gravity
  - -public supply
  - -pumped

2] Power Supply
- Public
- Generator
- Solar power
- Wind
- Water
- Biogas

3] Enclosure, Housing and or Handling Requirements based on species needs.

2.2.5 Approaches to Developing Animal Production Systems/ Concepts in Developing Intensive Animal Species Production Modeling

In this section you will be exposed to those concepts and considerations which must be used when designing ***any*** **"Animal Production System"** . This information would be important as you could one day be asked to design a system without all the system's components being known. What you should then try to do is to gather all that is known about a more popular related species within the same family as follows:
- the nature of the digestive system **[Digestion and Feeding]**
- the nature of the habitat and nesting sites of the species under consideration **[Housing and Environment]**
- the reproductive system and habits **[Reproduction and Breeding]**
- the social habits
- diseases which affect the species **[Disease Prevention and Control]**

Further considerations...

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- The **objectives** of the production system must be clearly identified, established or know from the start in order **to identify which physiological states** would have to be included in the production model or system.
- The **source of the animals** for the production system to be established will also need to be identified as follows:
    - wild Caught Captive Breeders,
    - wild caught juveniles for growth,
    - management of all physiological states,
    - other?

2.2.5.1. Considerations for species production modelling

The block diagram on this page presents a list of the **Important Considerations** for modelling the production of any species. Figure 10.1 presents the **Concepts for Developing an Animal Production System for any species.**

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Box 1: CONSIDERATIONS FOR SPECIES PRODUCTION MODELLING

The Species:

[I] **The Objectives of the Production System or Model**

[II] **The Species Life Cycle**

[III] **The Physiological States for the Production Flow**

[IV] **Performance Coefficients or Growth Parameters**

[V] **Reproductive Parameters**

[VI] **Animal Specific Needs as influenced by the Factors Affecting Animal Production**
Needs: **Housing-**
Nutrition and Feeding-
Health and Disease Control-
Reproductive Management-

[VII] **Animal Behaviour and Sociology**

[VIII] **Design of the Physical Environment Required**
- **Thermal Environment [LTC, UTC, Thermo Neutral Zone (TNZ)]**
- **Ventilation**
- **Humidity**
- **Air Quality**
- **Housing System [Space requirement; Trucking and Transportation considerations; Floor and Floor Surface type]**

[IX] **Management Routines Required**
- **Daily**
- **Weekly**
- **Monthly**
- **Seasonally**
- **Annually**

[X] **Variable Inputs Required**

[XI] **Output Expectations of the Model/**
Production Process Flow

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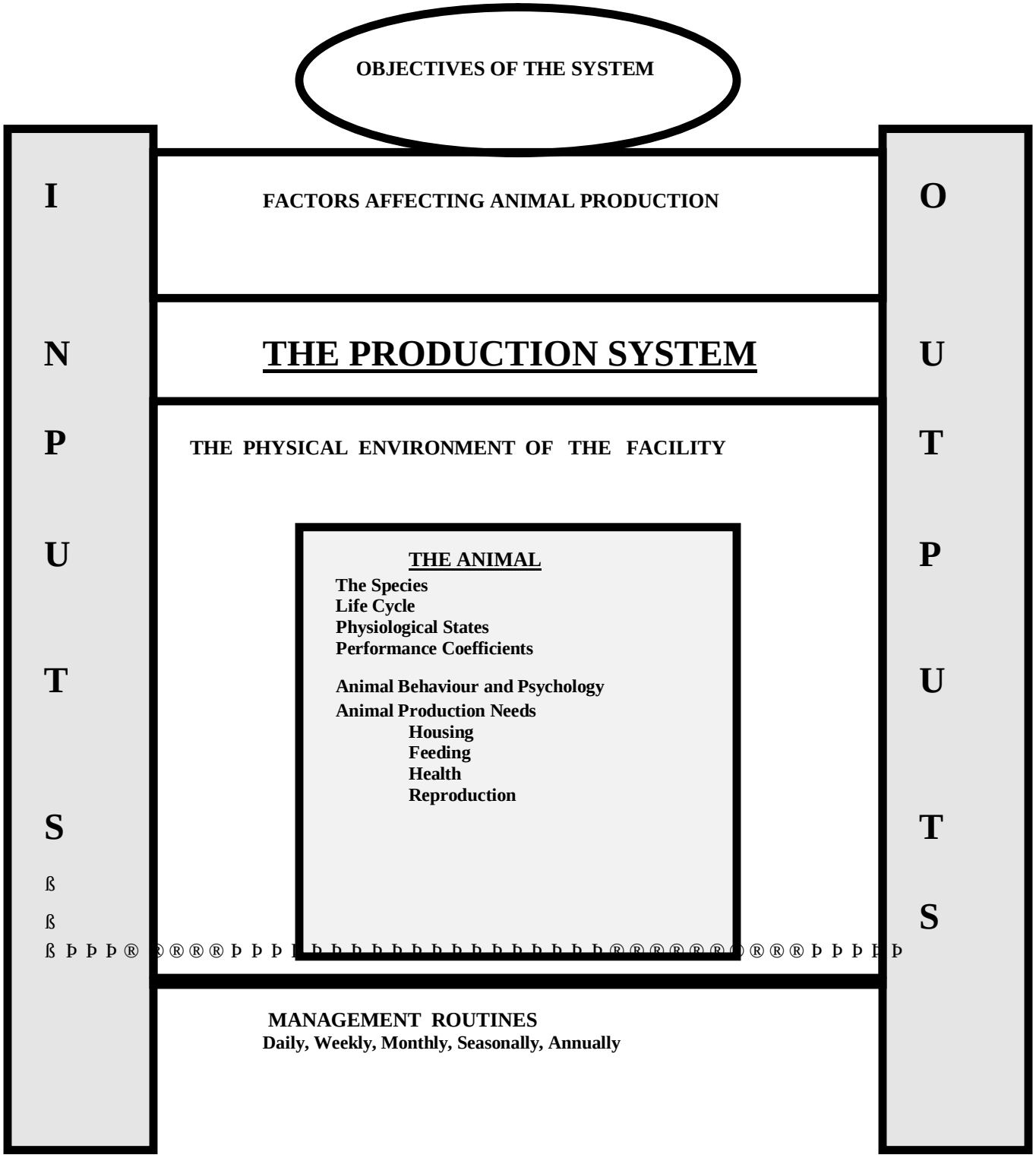

Figure 2.1: Concepts for developing an animal production system for any species.

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2.3. Wildlife Farming

2.3.1. Rationale behind Intensive / Semi-Intensive Wildlife Production / Farming:

Brown et Al (1994) reported that from a survey of fifteen (15) wildlife farmers in Trinidad there were two main types of farmers: **hobbyist** and **commercial farmers**.
The former viewed the animals as pets, while the latter reared the animals primarily for the meat, the by-products such as the hides were utilised to some extent.

A review of the literature available in Trinidad & Tobago on wildlife and wildlife farming revealed that in addition to providing recreation and food, wildlife farming could contribute to the socio-economic development of rural communities. This activity provided supplemental income to the farmer and generated additional employment. The export of wild-meat and animals for pets (caged birds, reptiles such as the *Boa constrictor constrictor* and *Caiman crocodilus*) is also possible. Wildlife farming can also be integrated into mixed or sustainable farming practices. Research and educational opportunities in wildlife farming are vast.

Captive bred stock will prevent the possible extinction of the indigenous animal wildlife species. In Trinidad and Tobago these animals include the agouti (*Dasyprocta leporina*), lappe (*Agouti paca*), cocrico (*Ortatis ruficauda*) and the deer (*Mazama americana*). In the other islands of the Caribbean other specie could be included, e.g. the Mountain Chicken in Dominica; the Jamaican Rock Iguana and the Huiti in Jamaica; and the list goes on……

Wildlife Farming could also ensure that there will be a gene pool in the wild for future work in the improvement of the captive reared wildlife stock. It was concluded that, wildlife farming had a multi-purpose role to play in Trinidad & Tobago and should be encouraged.

2.3.2. The Evolution of Wildlife Farming in Trinidad & Tobago

Hislop (undated), defined wildlife farming as the rearing or keeping of (game) animals for the purpose of captive breeding. In Trinidad & Tobago these game animals have included the following :

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(i) - agouti (*Dasyprostya aguti* now *D. leporina*),

(ii) - alligator / spectacled caiman (*Caiman sclerops*)
(iii) - cocrico (*Ortalis ruficauda*),
(iv) - deer/ red brocket deer(*Mazama americana*),
(v) - iguana (*Iguana iguana*),
(vi) - lappe / spotted paca (*Agouti paca*),
(vii) - manicou/ black eared opossum (*Didelphis marsupialis insularis*),
(viii) - morocoy (*Geochelene spp.*),
(ix) - tattoo/ nine banded armadillo (*Dasypus novemcinctus*),
(x) - wild hog/ quenk/ collared peccary (*Tayassu tajacu*).

Persons who have kept and successfully reared the species mentioned above or any other non-domestic species, may be considered a "Wildlife Farmer." There appears to be two categories of wildlife farmers, the hobbyist and the backyard farmer (Hislop, undated, b; Hislop,1987). James (1988) reported that captive rearing of wildlife has been practised in many rural communities in Trinidad & Tobago for several years. This was carried out as an underground operation because of the fear of prosecution. Asibey (1986) suggested that there was no legal prohibition against the keeping of game animals in captivity. However, wildlife farmers should not dispose or trade their animals during the closed hunting season (i.e. April 1st. to September 30th. annually). James (1988) indicated that international conservation and international development organisations have begun to lend support to captive-breeding of wildlife as a basis for food production. These included the **International Union of Nature and Natural Resources**; the **Smithsonian Institute**; and **United Nations Food and Agriculture Organisation**. Recently several governments, including that of the Republic of Trinidad & Tobago have become aware of the importance of wildlife farming as a form of economic activity to be exploited or explored by rural communities. Official sanctioning and encouragement of wildlife farming has led to the discovery of a large pool of active farms. These farms were run mainly as hobby units for recreation and after retirement, or as a peasant/ subsistence type operation to supplement incomes. With Dr. Asibey's encouraging initiatives, co-operation among existing farmers was fostered through the formation, in 1984, of the **Wildlife Breeders and Farmers Association**. This association provided the ideal avenue for co-operation between the Ministry of Food Production Lands and Marine

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Resources and wildlife farmers, which continued to flourish to the present. The support of the Wildlife Section of the Forestry Division in the Ministry of Agriculture under the direction of Dr. Carol James has been encouraging.

2.3.3. The role of wildlife farming:

An examination of the literature suggested that wildlife farming has a multipurpose function in society. The roles of wildlife farming can be categorised into the following:-

production of food and commercial products;
economic opportunities;
rural development;
recreation and aesthetics;
religious activities;
biological pest control;
integrated farming;
education; and
conservation benefits.

At present at the Department of Food production, Faculty of Agriculture and Natural Sciences at the UWI, St. Augustine there exists the Open Tropical Forage – Animal Production Laboratory [OTF-APL] where we are attempting to develop animal production models and systems of production for the following species of non-domestic animals:

Rodents:	**Agouti**	**(*Dasyprocta leporina*)**
	Capybara	**(*Hydrochoerus hydrochaeris*)**
Reptiles:	**Iguana**	**(*Iguana iguana*)**
	Red tailed Boa	**(*Boa constrictor constrictor*)**
Marsupial:	**Opossum**	**(*Didelphis marsupialis insularis*)**
Aquatic:	**Cascadura**	**(*Hoplosternum Littorale*)**
	Tilapia	**(*Tilapia nilotica*)**
Avian:	**Cocrico**	**(*Ortalis ruficauda*)**
Suiformes:	**Collard Peccary or Quenk**	**(*Tayassu tajacu*)**

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Two books have been written so far on the production of the above species, one on the Agouti and on eon the Collared Peccary/ Quenk / Wild Hog. They are on sale at the UWI Bookshop.

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