

# Factors Influencing the Growth and Development of Meat Animals

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## Abstract

Growth is an increase in tissue mass. Tissue mass increases by hyperplasia early and hypertrophy later in life, although hyperplasia of adipose tissue continues throughout life. In cattle, certain growth features are controlled by recessive genes which have not so far been controlled, complicating breeding. One such trait is double muscling or abnormal growth of meat animals which causes muscle hypertrophy and thereby increase in animal commercial value. 'Meat animals' are animals that furnish meat for human consumption. The growth and development of meat animals depend on several factors like environment, management practices, and genetics. The growth and development of meat animals are largely affected by two important factors. The first one is genetic factors, which it includes disease resistance, feed conversion efficiency, breed, and abnormal growth rates. The second most important factor is non-genetic in origin and it encompasses factors like nutrition, management, disease control, and environmental conditions. In plant feed animals, environmental factors influence the availability of nutrients. Heat regulation in livestock, especially cattle, is of great economic significance, because mammals attempt to maintain a constant body temperature. Low environmental temperature prolongs animal development, and high temperature also tends to retard it. Therefore, in this review, we will address those factors that greatly hinder the growth, development, and performance of meat animals worldwide.

## Introduction

The livestock sector is highly dynamic throughout the world. In developing countries, it is evolving in response to continuously growing demand for livestock products. Livestock in Ethiopia are important in many ways; as employment generation, store of wealth; form of insurance, recycle of waste products and residues from crops and agro-industries, improvement of the structure and fertility of soil. Ethiopia has large number of ruminants (59.5 million cattle, 30.70 million sheep, and 30.20 million goat populations) [1] having high contribution for meat consumption and generates income from export of live animals, meat, edible organs and skin. However, many factors affected the maximum benefit to be obtained from this livestock production [2]. In spite of the presence of huge number of ruminant population, Ethiopia failed to optimally exploit these resources due to a number of factors such as drought, infrastructure problem, different animal disease, shortage of feed, poor management practices, and lack of skilled man power and poor governmental policies for disease prevention and control [3].

When livestock performance is considered, it depends mainly on the genetic potential of the animal. On the other hand, like optimum nutrition, good management and disease control and others, permit full expression of this genetic potential. So, improvement in genetic capabilities as well as environment could only be the suitable way for animal improvement. Knowledge on selection and breeding program and management practices is very essential to increase the growth and development of meat animals. For any improvement program, genetic parameters like heritability, repeatability and genetic correlation are inevitably important in all the situations [4]. Heritability means the amount of trait transmitted from parents to offspring. When the genetic effect on a trait is strong, the trait is highly heritable so selection has the most important thing. When the genetic effect on a trait is weak, it is lowly heritable trait and the environment has the greatest influence on that trait. Both the animal's genes, and the environment in which it lives, shape its traits. Economically important traits in beef cattle like growth rate, carcass characteristics and fertility genes influence are all affected by the external environment and by the genetic make-up received from their parents [5].

Favorable conditions, such as, adequate photoperiod, thermo-neutral conditions, food availability in quantity and quality, and a low stress environment should also be maintained. The body temperature of most domestic animals is considerably higher than the environmental temperature to which they are mostly exposed, so they maintain their body temperatures by balancing internal heat production and heat loss to the environment. Know a day, limited feed supplies and high feed prices have increased producer's awareness of feed efficiency. Feed efficiency has been studied for

decades yet only minimal progress has been worked out in the beef industry. Recent advances in technology now allow for individual feed intakes to be recorded on cattle fed in large groups. Different research has largely focused on identifying superior cattle during the finishing phase when cattle are fed grain based, high-energy diets. However, the cow herd consumes a lower energy, forage based diet. Further research is needed comparing efficiency measure on high-energy, grain diets and low-energy, forage diets. It is important to understand the impacts of selecting for feed efficiency on cow herd reproduction, productivity, and longevity [6]. Therefore, the aim / objective of this review is to discuss the factors that influence the growth and development of meat animals.

## Insights to the Literature

### Genetic factors on growth and development of meat animals

Hundreds or thousands of genes are contributing to most of the important traits of beef cattle. These are called quantitative traits. Unlike traits controlled by major genes, these traits do not have distinct forms but fit into a range. An example is growth rates, which vary from extremely low, right through to extremely high. Traits influenced by multiple genes are more influenced by the environment than traits controlled by major genes [5]. Some of the genetic factors that influence the growth and development of meat animals' are as follows:

**Disease resistance:** Defense mechanism of animal can be divided into two broad classes: resistance and tolerance. Resistance traits reduce the harm caused by disease by preventing infection or limiting subsequent pathogen growth and development within the host through avoidance or clearance of infection. Tolerance traits do not inhibit infection, but instead reduce or offset its negative fitness consequences by reducing the additional mortality due to infection or restoring the reproductive ability of infected individuals) [7]. Resistance and tolerance can both increase the fitness of an infected host individual, but resistance does so by necessarily limiting pathogen fitness, whereas tolerance does not [7,8].

**Feed conversion efficiency:** Individual feed conversion efficiency is a major trait that influences the usage of energy resources and the growth of beef cattle. The underlying biological processes of feed conversion efficiency are complex and are influenced by factors as diverse as climate, feed properties, gut microbe, and individual genetic predisposition. The sustainable and efficient usage of resources in animal production is a major concern in agriculture. Over the last decade, increasing amounts of agricultural land and plant products have been used for ethanol and energy production, raising the economic pressure on animal production through higher feed costs. Studies of livestock species showed that including feed efficiency as a trait in breeding schemes provides the potential to save feeding costs and resources while increasing productivity and reducing greenhouse gas emission and growth of beef /meat animals [9].

**Breed:** It is widely accepted that carcass and meat quality can be

influenced by several factors, such as feed [10], age [11] and genotype [12,13]. Factors related to meat sensory characteristics (color, cooking losses and tenderness) and meat quality (intramuscular fat and fatty acid) could be also affected. These parameters are considered important as quality indicators and they have an impact on consumer acceptability [13].

The growth and carcass composition traits differ between breeds within all farm animal species. As an animal matures, it undergoes an increase in the ratio of muscle to bone, followed by a decrease in muscle growth rate and an increase in the ratio of fat to muscle [14]. However, different breeds differ in their rate of maturation and average mature weight. Therefore, standardizing measurements of body composition (proportions of muscle, fat and bone) to the same stage of maturity of body weight results in much less variation in carcass composition than standardizing to the same age or weight. In beef cattle, late-maturing breeds, like the Continental European breeds, are often preferred under conditions of good nutrition, producing heavier carcasses with little fat. Early maturing beef breeds, such as the traditional British breeds, also produce good quality meat with low proportion of fat [14].

**Abnormal growth factors:** There are several non-pathological factors that can cause abnormal or unusual growth and development of meat animals, such as double muscling, abnormal hyperplasia, hypertrophy and steatosis. Double muscling is the genetic condition of cattle causing them to have unusually thick, bulging muscles. Animal exhibiting double muscling have a lower proportion of red fibers and higher proportion of white fibers as compared to normal animals. The white fibers are larger than red fibers which along with the increased proportion of white fibers, accounts for a hypertrophic condition of the muscle. When double-muscled cattle are compared to normal cattle, growth is more rapid, development of muscle is greater, and fat deposition is less. The muscle to bone ratio is greater, being on the order of 6:1. Condition similar to double muscling exists in other meat species although of different genetic origin. Pig, sheep and turkey sometimes exhibit muscle development that is equal to extremes of double muscling [15].

Steatosis is characterized by extensive fat infiltration into muscle fibers. Fat replaces the content of muscle fibers and the gross muscle appears to almost completely compose of fat. It is a non-inflammatory, non-pathological condition where in no evidence is visible until the carcass is cut. The condition may be occurring in beef, lamb, and pork [15].

### Non-Genetic factors on growth and development of meat animals

There are a number of non-genetic factors that affect the growth and development of meat animals. Factors, such as, sex of born calves, season, year of birth, and others affect growth traits, and directly obscures in the expression of actual genetic worth [16]. Several previous works reported that growth performance can be influenced by season of birth, age, parity, year and fertility of the dam, breed and sex of the calf. Apart from the genotype effects; sex, year of birth and

parity are the main non-genetic factors that influenced growth and daily weight gain traits until one year of age in Horro (Zebu) and their crosses with Holstein Friesian and Jersey cattle in Ethiopia [17].

**Nutrition:** The type of cereal used in the birds' diet [18,19] had an impact on the amount of fat deposited and also the fatty acid proportion [20]. Thereby, the quality of the fatty acid could be improved increasing the unsaturated fatty acids content (greater proportion of components from the  $\alpha$ -linolenic fatty acid family) respect to saturated acids [21]. Although heredity indicates the maximum amount of growth and development that is possible, nutrition along with other environmental factors, governs the actual rate of growth and extent to which development is attained. Utilization of ingested nutrients is partitioned among various tissues and organs according to their metabolic rate and physiological importance. Maintenance and function of vital physiological system such as nervous, circulatory, digestive, and excretory systems, take precedence over muscle growth and fat deposition. The order of precedence is as follows: a) tissues that constitute vital organs and physiological process, b) bone, c) muscle, and d) fat deposition [15].

During pregnancy, the developing fetus holds a priority similar to that of vital tissues and organ of dam. Differences in the plane of nutrition at any age from the late fetal stage of maturity not only alter growth generally but also affect the different regions, the different tissues and the various organs differentially. Thus animals on different planes of nutrition, even if they are of the same breed [15].

The efficiency of meat animals in converting feed into meat is generally related to the level of feed intake, but the relationship is rather complex. Highest efficiency in converting feed energy into body weight is achieved when animals are fed ad libitum. But, if feed energy intake exceeds the amount needed for lean tissue growth, the excess is used for fat deposition. Thus, animals' full-fed high-concentrate diets usually produce more carcass fat, and consequently, are less efficient in converting feed to lean meat than are animals fed slightly below ad libitum energy intake, even though the ad libitum fed animals would be more efficient in total feed energy retention. This is particularly evident in the later growth stages, as muscles and bone approach their mature sizes. Slight to moderate feed restriction is an effective procedure to modify body or carcass composition. The abdominal fat in broilers chicken can be reduced by a 3 to 5 day period of feed restriction, beginning at 5 to 7 days of age. Slight feed restriction of mono-gastric animals, particularly in the later growth stages, will produce leaner animals at slaughter, but limit feeding requires more labor and housing and animals reach acceptable slaughter weight more slowly. The additional cost associated with restricted feeding may surpass the additional value of leaner carcasses. Dietary energy of ruminant animals may be restricted conveniently by including variable amounts of fiber in the diet [15].

**Protein:** An adequate and continuous supply of protein is required in animal diets for growth and maintenance of tissues. Proteins are composed of various amounts and kinds of amino acids, some of which cannot be synthesized in animal body. These are called

essential amino acids, and must be present in the diet of animal. Every animal has a daily need for dietary protein. Although animals cannot synthesize tissue proteins beyond their genetic potential by consuming excess protein, the rate of growth is readily reduced by an inadequate dietary protein. Growth rate in mono-gastric animals are reduced by an inadequate total amount of protein, a deficiency of any one of essential amino acids in the diet [15]. But in ruminant animals, amount and quality of dietary protein are less critical than in mono-gastric animals.

**Fat:** Dietary fats are used by the animal for energy, and certain fatty acids are essential for growth. They also may be assimilated and deposited as body fat. Composition of deposited fat varies among species. All meat animals are able to synthesize fatty acids and/or adipose tissue from carbohydrates and proteins, and the fat which is deposited is characteristic of the species. Fats in the diet of mono-gastric animals may assimilate and deposited in relatively unchanged form; whereas, dietary fats consumed by ruminants undergo degradation and synthesis of more saturated fat by rumen bacteria before assimilation and deposition. Carcasses from mono-gastric animals fed a diet containing a specific type of fat will have fat deposits of similar chemical composition to the dietary fat. For example, pigs or chickens fed a diet high in unsaturated diet will have soft, oily carcass fat. However, the rapid turnover of depot fats permits the replacement of deposited fat by dietary changes [15].

**Hormones:** growth hormone produces lean tissue growth throughout in animal. It is produced by anterior pituitary gland and promotes the release of class hormones from the liver and other tissues known as somatomedins. The somatomedins have insulin like activity and are responsible for protein synthesis associated with somatotropin. Such hormone-induced protein accretion partitions the utilizations of nutrients towards lean tissue growth and away from fat deposition [15].

The hormones of testes and ovaries play an important role in growth and development of body. Differential rate of growth and development as well as tissue composition are associated with sex of animals. Males usually grow faster, mature later, and have carcasses that are more muscular and less fat than females. Most of the time meat animal producers frequently castrate on male animals, a practice that modifies behavior and sometimes improves meat quality, but causes deposition of more fat and less muscle during growth. The principal hormones produced by the testes are androgens; those produced by the ovaries are estrogens and progesterone [22].

Androgens stimulate growth in muscles by increasing protein synthesis, an action that is accompanied by decreased fat deposition. Certain muscles are more sensitive than others to effects of androgen, depending on their role in reproduction. In particular muscles of fore quarter of the male, especially those in neck and crest region, show greater development than in females [15]. Estrogens generally have little or no effect on skeletal muscle protein synthesis, but they are effective in promoting deposition of body fat. Specific effects depend on proximity to puberty and estrogen concentration. Females

generally fattened at younger ages and lighter weights than males. With the exception of gilts, they are also fattening more quickly than male castrate. Gilts tend to fatten and mature later than barrows. Estrogen like androgen, stimulate bone salt deposition and even more effective in causing epiphyseal plate closure. Therefore female mature earlier than males [15].

**Management:** In groups, animals interact and develop relationships among themselves. Relationships are dominant-subordinate to establish a socially dominant hierarchy. In cattle, dominance-related interactions cause stress, bruises and physical injuries. Since cattle feedlot systems may be restrictive to key resources such as self-grooming substrates, shade, feeding spaces and comfortable lying places [22]. Competition for some of the above-mentioned resources may produce disturbances and subsequent biological costs to the animals. Research by Crespo and Esteve [22] and Partida et al. [23] discussed the effect on meat quality of different cattle groups classified by social dominance index (high, medium or low). In dairy breeds (Friesian), dominance did not affect sensorial parameters [22] although observed that in breed of beef the taste panel judgment was affected by social rank with regard to tenderness and some odor and flavor scores. Animals from the medium and high ranks had the highest scores in tenderness.

Poor management aggravates some environmental factors such as, temperature, wind, light and humidity. Nutrition is often the most important environmental factor influencing the productivity of beef cattle. Nutrition is affected by the type of country, pasture type and seasonal conditions. Management can influence the quality and quantity of nutrition available by techniques like manipulating stocking rates and use of supplements.

**Disease control:** Disease control contingency plans should be in place at a national level and should contain details of management structure, disease control strategies and operational procedures; animal welfare considerations should be addressed within these disease control contingency plans. The plans should also include a strategy to ensure that an adequate number of personnel competent in the humane killing of animals are available. Local level plans should be based on national plans and be informed by local knowledge. The operational activities should be led by an official veterinarian who has the authority to appoint the personnel in the specialist teams and ensure that they adhere to the required animal welfare and biosecurity standards. When appointing the personnel, he/she should ensure that the personnel involved have the required competencies [24].

**Environment:** Environmental conditions under which animals are reared may have marked influence on growth rate and even on body composition. The subject of heat regulation in farm animals has a wide economic significance. Sheep, cattle and pigs attempt to maintain their body temperature at a constant value which is optimum for biological activity [15].

The environment has the greatest influence on lowly heritable traits. It also includes parasites, diseases, seasons, pregnancy status, lactation status, castration status, water quality, forage quality,

management groups etc. Some environmental factors have permanent effects on cattle while others are only of a temporary nature. For example, poor nutrition and calving young commonly combine to permanently affect beef cattle [15].

## Conclusions

In general, growth and development of meat animals are largely affected by two important factors. The first one is genetic factors, which it includes disease resistance, feed conversion efficiency, breed, and abnormal growth rate. The second most important factor is non-genetic in origin and it encompasses factors like nutrition, management, disease control, environmental factors, etc. In order to exploit the resources of meat animals with optimum amount, favorable conditions, such as adequate photoperiods, thermo-neutral conditions, availability of food in quantity and quality, a low stress environments, and control of diseases should be fulfilled.

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## Conflicting of Interests

Authors declare that no conflicting of interests in the publication of this article.

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