CHAPTER 2

LITERATURE REVIEW

2.1. Background information about Vietnam

Vietnam is situated on the Indo-Chinese Peninsula. The country's area is approximately 331,688 km^2 and stretches in the shape of the letter S for more than 1,600 km, forming the eastern edge of the Southwest Asian mainland. It shares borders with Lao PDR to the northwest, Cambodia to the southwest and China to the north.

Because of differences in latitude and the marked variety of topographical relief, the climate tends to vary considerably from place to place. The winter (the dry season) is extending roughly from November to April. The winter season in most parts of the country is dry compared to the amount of precipitation in the summer season. About one-third of Vietnam's land area lies above 500 m a.s.l., great parts of the country enjoy a subtropical or, above 2.000 m a.s.l., even a temperate climate. Most of Vietnam receives around 2,000-3,000 mm of rain annually (Xuan et al., 2006). The average annual temperature is generally higher in the plains than in the mountains and plateaus, as well as higher in the South than in the North.

Animal production in Vietnam represents 20-25% gross value of total agricultural production (Ly, 2004). Livestock in Vietnam is predominantly raised on small-scale production units or household farms. At present, smallholder producers supply the majority of meat to the market, with most of the households operating individually in the production and marketing of livestock and livestock products (Lapar et al., 2003). More than 92% of producers only utilise household labour for livestock management (compared to 62% in general agriculture); and 0.77 ha of land on average are cultivated (Nin Pratt et al, 2003).

Lowland farmers, as well as ethnic minorities in the mountainous areas raise the highest number of domesticated livestock (Ly, 2004). In the hilly mountainous areas, rearing of livestock (pigs and draught animals) on smallholder farms is part of a system of mixed agricultural production (rice, other crops, fruits, vegetables). Animals are an essential component on these farms. They contribute to crop production (tillage, manure), harvesting and marketing (carriage), as well as food security and food variation (Suzuki, 2005).

Mixed farming systems in which livestock rearing and cropping production are the main components are at present very common models of farming systems in Vietnam (Viet et al, 2010) The traditional farming basically integrates a system of rice, root crops, fruit, vegetables, livestock and poultry (Xuan et al., 2006). The well-known integrated system of rice and other crops, livestock and poultry, aquaculture is called the V.A.C. system ("Vuon-Ao-Chuong", which means garden (crops) – pond (fish) and stable (animals)) (Ogle and Phuc, 1997). Thus, in order to achieve highest benefit, a combination of efforts has to be made in the development of crops, fish and animal production. Farmers often integrate crops and animals to maximize the returns from their small land area and income per capita (Paris, 2002). Other objectives include the minimization of production risks, diversification of income sources, guarantee of food security, increase in land productivity and improvement of production sustainability (Thang, 2010).

In the mountainous areas, where forestry is more developed, the V.A.C. system expands into V.A.C.R. ("Vuon-Ao-Chuong-Rung", R means forestry). This close integration is obvious, as the animal provide draught power, manure for crop production, and the latter particularly providing crop by-products that could not be used directly by men. The indigenous animals can eat a large volume of forage and crop by-products, which will also stimulate the development of vegetable and green fodder to restore soil fertility. It is emphasized that a huge volume of organic manure (from animal dung and excreta) contributes to the high yield of crop production, it maintains the soil fertility and prevent its erosion (Ly, 2004).

Another characteristic of the traditional farming systems in the north of Vietnam is their low input pattern. The farmers are used to raise indigenous breeds and feed them with locally available feed resources. With this feeding system, the output is low, but the profit is sustainable for poor farmers even under unstable market conditions (Ly, 2004).

Livestock keeping in Vietnam is still described as subsidiary to crop cultivation, but this is steadily changing and animal husbandry is getting more and more important (Vang, 2003). However, the main animal production system remains very traditional. Its primary function is to satisfy the demands for meat, milk, eggs, draught power, transportation and organic manure supplementation for crop cultivation. In some regions, farmers use animals as a "bank" to store money (Vang, 2003). In parallel to the traditional system, there is a tendency to develop the medium- and large-sized livestock farms (Vang, 2003). Farmers, especially in peri-urban areas, where there is a big demand for animal products, are getting used to intensive husbandry with the "high input – high output" model.

2.2. Beef cattle production in the north of Vietnam

The topography in North Vietnam consists of hills and densely forested mountains, with plains covering no more than 20%. In North Vietnam, mountains account for 40% of the area, with smaller hills accounting for 40% and tropical forests for 42%. Hillsides and hilltops are less densely populated, land pressure is lower, and infrastructure and markets are less available and accessible (Lemke et al, 2007). Lack of transportation, communication and irrigation systems are the biggest constraints to development of this region (Suc and Binh, 2001)

The Yellow Cattle is the most common breed of cattle in the north of Vietnam (Burns et al., 2002). These cattle are extremely well adapted to the climate and to the local feeding conditions and are fertile as well. The Yellow cattle are highly tolerant to diseases and pests, such liver fluke parasites (Ly, 2004).

Yellow cattle are used as a dam line for beef and dairy cattle in breeding programmes. In the upland areas, each family usually owns between two and five heads of buffalo and/or cattle. The number of households raising dairy cattle is increasing, owing to the government policies (Ly, 2004).

Farmers raise cattle mainly for long-term savings and as draught animals (Rodríguez et al., 1997). In 1999, Yellow cattle accounted for 75% of the total cattle population (Tjällden, 1999). This native breed is mainly used for draught power. The population of Yellow cattle could not meet the increasing demand for beef due to their small body size and the low growth performance under the prevailing husbandry conditions (Thuong, 1996).

2.3. Beef cattle breeds and breeding programmes in Vietnam

There are up to seven groups of indigenous cattle all over the country and they are considered to be one breed (Yellow cattle) (Vang, 2003). The genetic phylogeny of these breeds has not been studied. Each group is popular in a certain region, depending on the interest of the people and its adaptability to local conditions. The indigenous cattle in Vietnam are small in size and have low performance in meat and milk production, but they can adapt well to harsh conditions and have a good reproductive capacity (Vang, 2003).

Some breeding programmes have been initiated in order to select beef cattle, including crossbred and native cattle. Weights and body conformation were the criteria for selection (Trach, 1998). Since 1920 (under the French rule) the first programme started with the crossing of Yellow Cattle with Red Sindhi, which were imported from Pakistan (Su and Binh, 2002). The Red Sindhi is often used by farmers to produce F1 offspring with Yellow cattle, when attempting to increase the size of their animals. The national programme under the Beef Cattle Development Project-VIE/86/008 lasted from 1989 to 1991. Some new crosses were introduced, with Bos taurus breeds, such as Brahman or Sahiwal crossed with the Laisindh. In 1996 a program entitled Profitable Beef Cattle Development in Vietnam (AS2/97/18) was initiated by the Australian Centre for International Agricultural Research (ACIAR). An important goal of this project was to find ways to increase the profitability of cattle reared by smallholder farmers, rather than assessing results only in terms of physical production or productivity measures. This project has focused on developing a crossbreeding programme to produce a mid-sized, 'easy care' animals with good growth and good fertility, while remaining well-adapted to the local environmental stresses (Burns et al., 2002). Hundreds local staff were trained to use AI technique. The project provided sperm of Australian breed bulls (Red Brahman, Drought Master, Belmon Red and Red Brangus) to mate with Yellow cattle as dam line. The objective was to produce a crossbreed with better performance and good adaptability to the local environment. The live weight of crossbred cattle at 200 days old in Vinh Tuong (Vinh Phuc) were 140.70 kg (crossed with Drought Master), 148.41kg (Belmon Red) and 124.52 kg (Red Brahman); at 400 days old are 147.70kg (Drought Master), 133.97 kg (Red Brahman), 133.70 kg (Red Brangus and 106.00 kg (Laisindh) (Ly, 2002). Some of the favored breeds for crossbreeding are Red Sindhi, Sahiwal, Red Brahman, which were well accepted by the farmers.

2.4. Cattle farms, type and management

Livestock in the north of Vietnam are predominantly raised in smallholder production units (Lapar et al., 2003). A study of Huyen et al (2010) showed that the number of cattle kept by small households in the lowlands is less than five, which is due to the limited land area and fodder availability. Tung et al (2007) obtained similar results and indicated a mean herd size for beef cattle in north-western Vietnam of 3.4 animals per farm. Households keeping less than three cattle accounted for nearly 50% of the total investigated households; 41% of the households kept three to five and 8% between six and ten animals, respectively. The small farms worked mainly in crop production, with cattle as a complementary activity due to limited fodder resources. The availability of feed resources for cattle was a major factor affecting herd size and cattle management on smallholder farms in the northern part of Vietnam (Huyen et al., 2010).

On small farms, cattle are managed on a low-input basis, utilising mixed feed resources of variable quality. Traditionally, cattle are basically kept to complement crop production. Due to limited arable land, priority is usually given to crops, and there is little grazing land available for ruminants (Trach, 1998). Ruminants usually get only controlled access to grazing on roadsides, fallow land and the raised boundaries between the rice fields and other cropping areas. During humid and cold winters in some mountainous areas, cattle are fed almost exclusively on rice straw with little homemade supplementation. The reduced availability and poor quality of these feeds result in reproduction disorders and loss of body condition.

2.5. Feed resources for cattle and potential of crop by-products

The total grazing area in the whole country is about 5 million ha with 329,000 ha of pastures, 58% of which are located in the Northern Mountains and Midlands (Vang, 2003). With an increasing population and the establishment of new industrial zones, natural pastures have been reduced to small areas mixed with crops and building constructions. The productivity of grasslands has been adversely affected due to their small extent and overgrazing; at present they are producing about 20 % of their potential, because of poor management. In hilly areas natural grazing is still important for feeding cattle and buffaloes (Mui and Binh, 2003). In the mountainous area, hilly land is either too steep to be grazed or the soil is too poor and dry. Pasture management has been neglected in the past and overgrazing has created serious damage to soils and vegetation causing erosion. The quality of grasses on natural pastures is poor. Re-growth of grasses is not strong enough and wild weeds easily dominate pasture areas (Xuan et al., 2006).

Crop production provides a range of residues and agro-industrial by-products that can be utilised by ruminants and non-ruminants. However, the climate in Vietnam, with 5-6 months of dry season, leads to scarcity of high quality roughage resources. In the suburbs, families rearing cattle have to set aside certain areas of land for growing grasses, as by-products of agricultural crops have been inadequately utilized. These include cereal straws (e.g. rice and maize), sugarcane tops, root crop tops and vines (e.g. cassava and sweet potato), rice bran and bagasse (Devendra and Thomas, 2002). Although the quality of agricultural by-products is low, their huge quantity makes them important for the development of animal husbandry in Vietnam (Xuan et al., 2006).

Rice straw occupies a very important role in ruminant feeding. Rice is the predominant food grain with two to three crop yields per year. It is estimated that approximately one kilogram of straw is produced per kilogram of grain harvested (Devendra, 1997). The total rice straw production was estimated at 21 million tons, mainly in plain areas (60%) (Vang, 2003). This amount is used as ruminant feed, fuel, litter. However, the potential of rice straw as feed for ruminants has not yet been fully exploited. Vast amounts of this renewable resource are burnt either on the field, or are used as cooking fuel. Some is used for other purposes, such as litter or mushroom production. An estimated 30% of rice straw is used to feed animals (Xuan et al., 2006), which is approximately six million tons per year.

Rice bran is also an important feed source for pigs and for dairy cattle, but is only used as a supplement for buffalo and cattle in periods of increased power requirements for traction. Maize stems gathered after harvesting are plentiful, but are rarely used as animal feed. Sweet potato vines are abundant and are used mostly for pigs rather than for buffalo or cattle. There are large amounts of peanut and soybean stems available, however, their harvesting period is very short and storage is difficult. Therefore, only little amounts can be utilised as animal feed and most of it is used as green manure (Xuan et al., 2006).

Sugar cane is a special industrial crop in Vietnam due to its important by-products. Sugar cane production in Vietnam is developing quickly and its by-products will become more important in ruminant feeding in the coming years. Sugarcane tops and molasses are important forages for ruminants in areas with prolonged dry periods (Binh et al., 2005a). Molasses is a high energy feed source for beef cattle and buffaloes and also for pigs. The amount of sugar juice remaining in sugar cane tops is a good energy source for cattle in the dry season. However, large amounts of sugar cane tops are wasted during sugar production. Seasonal harvest and lack of preservation methods are the reasons. In a study of Binh et al. (2005a), sugar cane silage with 0.5% NaCl, 1-2% molasses or 1-2% cassava grain can decrease pH level to 3.86-3.91 for preservation. The silage has good colour and odor. However, mold on the top part was reported, which needed to be removed. Urea treatment showed no formation of mold and an increase in crude protein content. However, the level of urea application must be higher or equal to 2%, in order to increase pH >8 and decrease NDF (Neutral detergent fiber) significantly (Binh et al., 2005a).

2.6 Methods to improve quality and preservation period of crop by-products

2.6.1 Rice straw treatment methods

Feed resources for ruminant production in many tropical regions are becoming increasingly important because of rising costs and limited feed resources. This is especially critical during the time of feed shortage in the dry season. Rice straw is an agricultural by-product, which farmers typically store for the use as a ruminant feed in many tropical countries (Moran et al, 1983, Trach et al, 2001, Khejornsart and Wanapat, 2011). However, rice straw is low in nutritive value with low levels of protein (2–5% dry matter), high fiber and lignin content (NDF 50%), low dry matter digestibility (65%), thus resulting in low voluntary feed intake (1.5–2.0%) (Wanapat et al., 1985). Methods for improved utilization of rice straw as winter feed for cattle have been studied for application in practice (Trach, 2000).

Various treatment methods have been used to improve the nutritive value of rice straw including physical, biological and chemical treatments (Wanapat et al., 1996). In 1981, Sundstol introduced the Dip-treatment methods (modification from methods of Beckman and Fingerling) (Ribeiro, 1992). The organic matter digestibility of dip treated straw is increased from 45-50% to 70-75% (Ribeiro, 1992). Moran (1983) studied about alkali-treated rice straw shows that alkali treatment improved the digestibility of organic matter and the metabolizability of dietary energy in rice straw but depressed appetite, leading to a reduction in both metabolizable energy intake and nitrogen retention.

A study of Zadrazil (1984, cited by Ribeiro, 1992), reviewing microbial conversion of poor quality products into feed, concludes that ***in**-vitro* digestibility of fungal substrates, decrease at the beginning of colonization by white rot fungi and increases afterwards. Straw may also be "ensiled" with other chemicals such as NaOH, Ca(OH), etc., at a relatively-high moisture content. No practical method for microbial treatment of fibrous materials has been developed yet, but the scope for such a method may prove to be great (Ribeiro, 1992)

The application of urea treatment to rice straw was addressed by many studies (Do et al., 1999, Tham et al., 2008; Sanh, 2008). Singh et al. (1982) have reported much higher growth rate in response to wheat straw treated with 4% lime plus 4% urea compared to 4% lime alone. A combination of 3% lime with 4% urea was more effective than 3% lime alone in increasing intake, digestibility, growth rate and feed utilization (Trach, 2001). The good results from lime plus urea treatments have further demonstrated that lime plus urea can be used together for straw treatment with better biological responses in comparison with either input used alone (Wanapat et al., 2009). Other researchers (Sirohi and Rai 1995; Zaman and Owen 1990, 1995; Pradhan et al., 1997, cited by Trach 2001) have also found that ensiling straw with lime and urea highly increase intake, *in-vitro* and *in-vivo* digestibility.

2.6.2 Urea molasses multinutrient block

The crop residues (e.g. wheat and rice straw, maize and maize stover, sugar cane tops and trash) are usually unbalanced in terms of nitrogen (N), mineral and vitamin content, and they are also highly lignified (Sansoucy and Hassoun, 2007). Consequently, their dry matter (DM) digestibility is reduced. Urea is one of the cheapest non-protein N sources that can be used to supply the rumen microbes with soluble N, which are deficient in the diet. As a common fertilizer, it is widely available at reasonable prices in most countries around the world.

The first trials of providing urea through feed supplementation blocks included common salt and urea gave satisfactory results in South Africa as reported by Altona et al. (1960), cited by Beames (1963). Later on, other experiments using molasses, urea and salt confirmed these results (Beames, 1963; Beames and Morris, 1965; Alexander, 1972 cited by Sansoucy and Hassoun, 2007). In the early 1980s, the work of Professor Leng from Armidale University in Australia, in cooperation with the Joint FAO/IAEA Division (Vienna) and the National Dairy Development Board (NDDB) (India), renewed interest in this technology, particularly in developing countries (Makkar, 2007).

Beames (1963) showed that cattle could survive for a long time on low quality roughage with only urea and molasses supplements. In some situations, up to 30% percent of the total crude protein requirements can come from the blocks (Makkar, 2007). The blocks have also prevented deaths during drought periods and after floods due to their fast production and ease in transport and store. Maximum gains from supplementing with UMMBs are achieved during the dry period in tropical countries, when the farmers have nothing except crop residues and poor quality grasses and weeds (Makkar, 2007).

In Vietnam, some researchers have observed low block intake and have tried to replace the hard blocks with a softer cake (Do et al., 2002). They reported greater intake. A “soft cake” is, by its nature, different from a block. The total intake might be controlled by the amount offered, but it is rapidly ingested, leading to a peak in ammonia concentration.

Several hundred formulas, with or without molasses, have been developed and tested according to the local availability, quality and price of ingredients for both cattle and buffaloes or dairy and beef cattle (Thu, 2000) and rabbits (Binh et al., 1991).

2.7 Marketing

One objective of production is profit. High profit usually is an incentive to develop production. To improve productivity of beef cattle production in the north of Vietnam, the marketing aspect needs to be observed. The small household's livestock production in this area is constrained by poor access to markets (Linh et al., 2008). There is also a lack of market institutions for livestock: animals are sold without being weighed; market information is scanty; quality grading is lacking; and there are few services, such as extension and health services that might improve the quality of the marketed produce (Williams *et al*., 2003; FAO, 2009a). As a result, information about markets is limited. The lack of an organized live animal market has resulted in a majority of products being informally marketed and distributed, with farmers selling at the farm gate, often in a face to face situation (Lapar et al., 2003). The farmers are rarely having direct contact with the livestock market.

Domestic trade is hindered by high transportation costs. Long distance trading of live animals to the big cities in the River delta is especially costly due to the additional effect of a substantial weight loss of the animals being transported over long distances. It is more difficult to transport live animals, because of the spreading of diseases in recent time. Marketing is also limited by restrictions concerning the movement of livestock products, of which only a minor part is imposed due to health-related reasons (IFPRI, 2001). Animal slaughtering, meat processing and distribution are characterized by unhygienic conditions due to poor practices and lack of infrastructure, such as the supply of clean water (IFPRI, 2001).

2.8 Genotype and environment interactions

A GxE interaction is a phenomenon whereby performances of different genotypes are not equally affected by different environments (Falconer, 1989). The definition of environment should not only include physical and climatic conditions, but also the production and health management, economic constraints, and the prevailing agricultural policies (Stanton et al., 1991). The knowledge of GxE interactions is considered to be important for policy makers, for animal breeders and especially for farmers in order to be able to select the appropriate cattle breed for a specific zone. The level of GxE interactions depends on zone, production system, weather and climate (Holmes et al. 1992; Vercoe and Frish 1992; Chaudhry et al. 1994).

Significant breed type (size) x management interactions have been reported (Buttram and Willham, 1989), which suggest that the optimal size of the cattle under specific conditions depends on the type of management implemented. Hence, determination of the effect of body size on growth traits will help to determine, whether there are certain body sizes of Yellow cattle more suitable for a specific environment than others. Large frame sizes are favoured in high-input systems of beef cattle production (Taylor et al., 2008) Because of the interaction between body size and forage plant ecology, small cattle may have a better ability to select feed for their productive and reproductive activities than larger ones, especially in the dry season (Phung, 2009).

However, selection for larger and faster growing cattle and its association to increased mature body size may be negatively affecting key reproductive performance traits (Vargas, 2000). Matching body size to available resources plays a major role in establishing a beef production system with optimized efficiency (Vargas, 2000).