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Comparisons of beef buffalo and beef cattle production systems in northeastern Thailand

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Comparisons of beef buffalo and beef cattle production systems in northeastern Thailand

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Dedication

To

My most beloved parents and grandmother

&

My most respectful teachers

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABA	Asian Buffalo Association
ACIAR	Australian Centre for International Agricultural Research
AI	Artificial Insemination
ANOVA	Analysis of Variance
BAAC	Bank of Agriculture and Agricultural Cooperatives
BLUP	Best Linear Unbiased Prediction
DLD	Department of Livestock Development
EBV	Estimated Breeding Values
FAO	Food and Agriculture Organization
FMD	Foot and Mouth Disease
GAPs	Good Agricultural Practices
GDP	Gross Domestic Product
ha	Hectare
IBIC	International Buffalo Information Centre
kg	Kilogram
MFA	Ministry of Foreign Affairs
MOAC	Ministry of Agricultural Cooperatives
n.s.	Not Significant
NSO	National Statistical Office
OAE	Office of Agricultural Economics
ONBS	Open Nucleus Breeding Scheme
ONEC	Office of the National Education Commission
SD	Standard Division
SE	Standard Error
SEM	Standard Error of the Mean
TLU	Tropical Livestock Units
vs.	Versus

SUMMARY

The goal of this study was to compare production systems and potential for further development of beef buffalo and beef cattle farms in northeastern Thailand aiming at an improvement of production and as a consequence of farmers' livelihoods. The specific objectives were:

1. to better understand and re-examine characteristics of the livestock farms and reasons for keeping livestock,
2. to assess socio-economic and livelihood benefits of the livestock for the farmers,
3. to investigate the livestock husbandry including farm management, feeding and breeding practices,
4. to explore farmers' perceptions of favourable traits of buffaloes and cattle and reasons for the decline of the buffalo population,
5. to investigate social and environmental impacts as well as problems and needs of the livestock farming according to the farmers' point of view.

The following hypotheses were tested to achieve the objectives of the study:

1. Characteristics of livestock farming and reasons for keeping livestock differ between beef buffalo and beef cattle farms and between herd sizes.
2. Differences between beef buffalo and beef cattle farms and between herd sizes have an effect on socio-economics and livelihoods of the farmers.
3. There are differences in farm management, feeding management and breeding practices between beef buffalo and beef cattle farms and between herd sizes.
4. Beef buffalo farms have a lower level of farm inputs and a higher potential for improving the production.
5. Community and environmental conflicts are caused by livestock farming depending on animal species and herd size.

This study was conducted in the province of the Nakhon Ratchasima, located in the lower part of northeastern Thailand (as shown in Figure 3.1, in **Chapter 3**). The multi-state sampling method was used to choose the farms based on the livestock production census in 2006 obtained from the Nakhonratchasima Provincial Livestock Office, Department of Livestock Development. Based on

this data, 121 beef buffalo and beef cattle farms, respectively, were selected randomly. Between October 2007 and May 2008, a single-visit, multiple-subject survey was carried out using face-to-face interviews. The recall, observation and measurement method was used to complete a pre-tested, semi-structured questionnaire. The opinions and views of the farmers were gathered by open-ended questions. Questionnaires included farm characteristics, importance of livestock, socio-economic benefits of the animals, feed resources, feeding management, herd structures and breeding practices, favourable traits of buffalo and cattle, reasons for the decline of the buffalo population as well as constraints and needs for the development of livestock farming. All data were statistically analyzed to describe the livestock farming systems and to compare beef buffalo and beef cattle farms and sizes of herds.

Characteristics of beef buffalo and beef cattle farming as well as the roles and the socio-economic benefits of the livestock to the keepers are presented in **Chapter 4**. Most of the farms were integrated crop-livestock systems with small farm size (7.9 ha), whereof less than half of the area was used for livestock. Farm activities were mainly done by family members while employees were only found on large farms. The most important reason for keeping animals was income generation (80 % of all responses). This could be classified into accumulation of wealth or savings (22 %), covering expected (19 %) and unexpected (19 %) expenses, and regular (11 %) and additional (9 %) sources of cash income. Besides this, improvement of the social status was mentioned (18 %). Only 2 % of the farmers kept the animals for draught power, inherited asset, manure source and conservation aspect. Most of planned and unplanned expenses of households during the last 5 years were covered by selling livestock (58 %) and other agricultural products (19 %). The more animals the farmers kept the better the dwelling conditions, the larger the number of household assets and the more access to commercial health insurances the farmers had. The results confirm the important roles of buffaloes and cattle in the livelihood strategies of rural households.

Chapter 5 presents feed resources for beef buffaloes and beef cattle throughout the year and feeding management of the livestock farms. Most of the livestock farms (94 %) practiced a herding system while tethering was used only by smallholders. The animals were kept on small pasture areas (3.1 ha) with very low pasture allowance (0.1 ha TLU^{-1}, TLU = Tropical Livestock

Units). During rainy season feed was obtained mostly from communal grasslands while harvested crop fields, shared by the community, became the most important source of feed during dry season. Therefore, major limitations of feed supply were low quantity and quality because of limited resources, variation of cropping patterns and seasonal fluctuations. Due to the lack of lands, low investment in pasture cultivation and seasonal limitations, farmers were not able to offer green forages to their animals throughout the year. Crop residues were used to fulfil animals' requirements during feed shortage or throughout the year. Because of high cost and low availability, farmers rarely practiced feed supplementation even though breeding animals were given the highest priority for supplementation. An extensive feeding system is mainly practiced on resource-poor farms, especially buffalo farms. The risk of feed deficiency is increasing if more animals are kept.

Herd structures, breed compositions and breeding systems of beef buffalo and beef cattle farms are reported in **Chapter 6**. The herd size in this study area was on average 39 buffaloes and 42 cattle per farm with a high variation. The size of herd had slightly increased over the previous years. Animals born within the herd were important sources of replacing buffaloes, indicating a high risk of inbreeding, while beef cattle farms imported animals from off-farm resources. Artificial insemination (AI) was not practiced for buffaloes while beef cattle farms adopted both natural and AI services. Damage of female's reproductive tract (38 % of responses) was stated as the most important problem of AI. Lack of semen was stated by buffalo farmers as a limitation of AI. Traits related to beef production were stated as high priority for buffalo selection, while cattle farmers preferred an attractive appearance. Thai swamp buffaloes, which are superior in beef production traits, comprised up to 91 % of the buffalo herd. On the contrary, crossbreds of native cattle and Brahman, and of native, Brahman and Indo-Brazilian cattle (88 % of the herd), having a more attractive appearance, predominated over the pure Thai native cattle breed (5 % of the herd). Native breeding bulls were not included in breeding programmes of cattle, which may result in the loss of genetic resources of local cattle in this area.

In **Chapter 7**, competitiveness of beef buffaloes and beef cattle, influences of animal farming on local community and environment, constraints and needs stated by the farmers, and reasons for the decline of buffalo farming are described. Buffaloes impressed the farmers by their higher

adaptation and productivity under extensive management as well as their superior beef production potential, fertility and longevity. However, the lack of water resources for wallowing was addressed as the most important reason for the decrease of buffalo farming (63 % of farmers). Due to a possible cause of water contamination and community conflicts, buffaloes sometimes were not allowed to enter public or private water resources. Deficiency of feed and water from communal resources (61 % of farmers) and the need to access more of these resources (43 % of farmers), particularly by large-scale farmers, were mentioned as the main constraints of livestock farming. Livestock services, marketing and prices also need to be improved by the authorities when a market-oriented farming system is emerging. A high competitive use of the communal properties, particularly by large-scale farms, sometimes caused social conflicts and environmental harms. However, livestock was regarded to improve soils and the local ecosystem.

Beef buffaloes and beef cattle can cope with the economic needs of the households as well as improve farmers' socio-economic status and livelihoods substantially. As market-oriented production systems are becoming more important than subsistent systems, livestock husbandry, government services and livestock marketing need to be developed in order to improve the productivity of livestock farming and consequently farmers' livelihoods. As regarding their high potential for beef production, effective water management strategies should be deliberately considered to alleviate the drastic decline of the buffalo population and to promote beef buffalo farm enterprises. Furthermore, community and environmental antagonists related to livestock farming need to be taken into account in the policies and promotions.

CHAPTER 1

GENERAL INTRODUCTION

General introduction

1.1 Foreword

In Thailand, buffaloes and cattle were previously used mainly for draught purposes in crop-livestock integrated farming system. Over the last years the socio-economic pattern of local farmers has changed and modern technology is more and more adapted. As a consequence, draught animals are replaced by machinery and animals are raised for meat production and to some degree for traditional purposes (Na-Chiangmai, 2002; Khemsawat et al., 2003). Competitions between cattle and buffaloes arise when they are kept in the same area and communal resources are used for pastures. Cattle are usually preferred due to their greater heat tolerance (Skunmen et al., 2001). Thus, the number of buffaloes has drastically declined during the last decade (Na-Chiangmai, 2002; Khemsawat et al., 2003).

The average farm area and herd size of Thai livestock production is small. An extensive grazing system is widely practiced by village farmers. The animals are traditionally kept in the back yard and fed on native grasslands and crop residues (Na-Chiangmai, 2002). Their feed supply is depending on seasonal differences and land use patterns (Kehren, 1999). Therefore, the production efficiency of smallholder farms is quite low. Other constraints are the low genetic potential of the native breeds, insufficient management and high mortality rates, particularly among young animals (FAO, 2002; Khemsawat et al., 2003). Due to the fact that local farmers mainly rely on public resources, public concern about the impact of animal production on human well being and the local environment rose in recent years. Moreover, many livestock farms which were located outside cities before are located in community housing areas or peri-urban areas now due to the expansion of residential areas and urbanization (Chantalakhana and Skunmun, 2002).

The beef consumed in Thailand is mainly produced by local cattle and buffaloes. The meat sold for local consumption and to meat processing factories is normally from the abattoir where live animals are purchased directly from the villagers. These animals are priced per head according to individual appearance and animal size, while the meat sold to local consumers is priced according

to weight (Na-Chiangmai, 2002). There is no "standard price" for beef animals in Thailand and livestock marketing is not well developed (FAO, 2002). Beef animals, especially buffaloes, have been exploited for various purposes such as draught power and meat production but are neglected by research, development and promotion programmes due to the fact that they are mostly kept by remote farmers, who usually have little or no influence on government or administrative decisions (Chantalakhana, 2001). In order to supply the high demand for beef and to reduce the large amount of high quality beef, which is imported to Thailand, because of the increasing human population and the increasing standard of living and education, as well as to improve the livelihoods of the farmers, smallholder beef farms have to improve their productivity (Na-Chiangmai, 2002). To achieve this, it is important to understand the behaviour of rural farmers, their existing farming systems, resources, limitations and potentials through inter-disciplinarity and the community-based approaches (Chantalakhana and Skunmun, 2002; Devendra, 2002a).

1.2 Problem statements

Although buffaloes and cattle have a great potential for production under extensive conditions, this special production system, especially for buffaloes, is neglected by research as well as by development and promotion programmes of the government. Efficient livestock development programmes in Thailand are still lacking. Thai farmers still operate their farms in a traditional form and modern commercial farming is adopted only in some areas. Uncontrolled mating and careless breeding practices are the main constraints for the improvement of livestock genetics. Thus, the productivity of Thai livestock farming is low and has influenced the farmers' well-being. As a result of the increasing beef cattle farming the buffalo population is declining. Reasons for this development should be investigated at the farmers' level in order to develop strategies to control this development. The information obtained through inter-disciplinary research and community-based participatory management has to be taken into account by the livestock farming promotion and development programmes in order to improve farm productivity and consequently livelihoods of the farmers and at the same time combine this with a sustainable development of livestock farming.

1.3 Aim and objectives of the study

The goal of this study was to compare production systems and the potential for further development of beef buffalo and beef cattle farms in northeastern Thailand aiming at an improvement of production and as a consequence of farmers' livelihoods. The specific objectives were:

1. to better understand and re-examine characteristics of the livestock farms and reasons for keeping livestock,
2. to assess socio-economic and livelihood benefits of the livestock for the farmers,
3. to investigate the livestock husbandry including farm management, feeding and breeding practices,
4. to explore farmers' perceptions of favourable traits of buffaloes and cattle and reasons for the decline of the buffalo population,
5. to investigate social and environmental impacts as well as problems and needs of the livestock farming according to the farmers' point of view.

1.4 Research hypotheses

Our objectives are achieved by testing the following hypotheses:

1. Characteristics of livestock farming and reasons for keeping livestock differ between beef buffalo and beef cattle farms and between herd sizes.
2. Differences between beef buffalo and beef cattle farms and between herd sizes have an effect on socio-economics and livelihoods of the farmers.
3. There are differences in farm management, feeding management and breeding practices between beef buffalo and beef cattle farms and between herd sizes.
4. Beef buffalo farms have a lower level of farm inputs and a higher potential for improving the production.
5. Community and environmental conflicts are caused by livestock farming depending on animal species and herd size.

1.5 Outputs and contributions

This study was carried out under field conditions in order to better understand the current situation of livestock farming, and to identify and diagnose farmers' point of views. The characteristics of livestock farming and the roles of livestock mentioned by the farmers are re-examined while the benefits of the livestock in terms of socio-economics and livelihoods aspects are investigated. Livestock husbandry including feed resources and feeding management throughout the year, herd structures, breed compositions and breeding practices as well as farm management are investigated. Beef buffalo and beef cattle farms are compared in terms of farm practices and farmers' preferences of animal traits. Furthermore, reasons for the decreasing buffalo population from the farmers' point of view are recorded as well as social and environmental aspects, constraints and needs of the livestock farms in this region are investigated. The results of this study are expected to support the formulation of appropriate policies and promotion programmes for developing the beef livestock farming.

1.6 Conceptual framework for the study

Dependent variables in this framework (Figure 1.1) consist of characteristics of livestock farms, reasons for keeping animals (as roles of the livestock), socio-economic and livelihood benefits of the livestock, livestock husbandry including year-round feed sources and feeding management, herd structures, breeds, breeding practices, social and environmental impacts of the farming, comparisons of favourable traits between beef buffaloes and beef cattle, reasons for the decline of buffalo farming, and constraints and prospects of the livestock production in the studied area. For independent variables, all collected aspects between types of livestock farms, namely beef buffaloes and beef cattle farms, as well as between sizes of livestock farms, namely small-, medium- and large-scale herds, are compared.

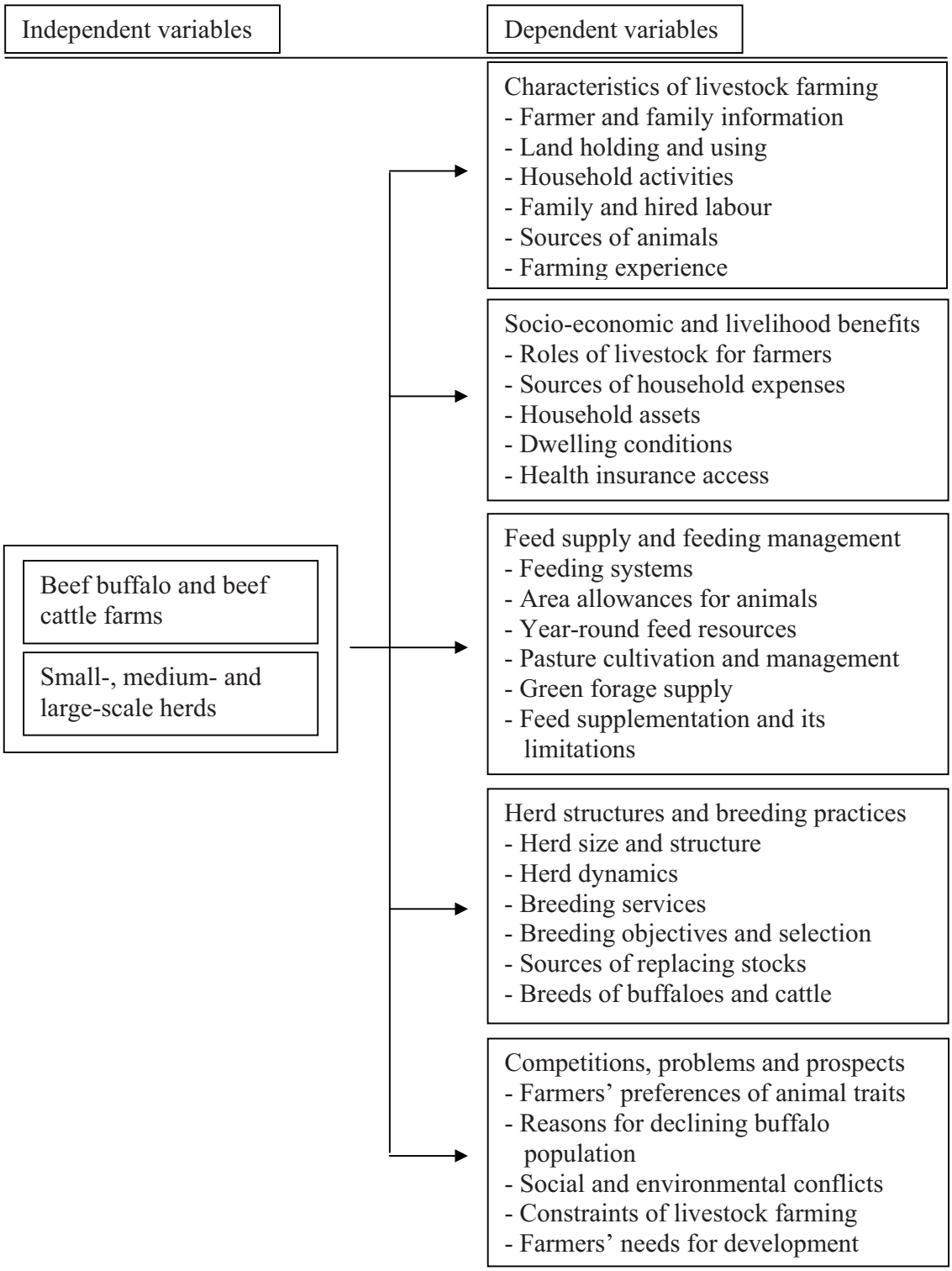

Figure 1.1: Dependent and independent variables in the analysis of this research

CHAPTER 2

LITERATURE REVIEW

Literature Review

2.1 General information about Thailand

Thailand is situated on the Indo-China Peninsula. The country covers an area of 514,000 square kilometres, lies in the heart of Southeast Asia, roughly equidistant to India and China. It shares borders with Myanmar to the west and north, Lao PDR to the north and northeast, Cambodia to the east, and Malaysia to the south. The general weather conditions throughout the country are those of a monsoonal tropical climate and remain hot throughout the year. Average temperatures are about 29 ^{o}C, ranging in Bangkok from 35 ^{o}C in April to 17 ^{o}C in December. There are three seasons: the cool season (November to February), the hot season (March to May) and the rainy season (June to October). The annual rainfall is about 1,500 mm. The Kingdom is geologically divided into four regions: North (mountainous region), Northeast (Khorat Plateau area, bordered to the east by the Mekong river), Central (predominately the flat Chao Phraya river valley) and Southern (the narrow Kra Isthmus) (Na-Chiangmai, 2002; Nakhonratchasima, 2008; MFA, 2010).

As estimated by the National Statistical Office, the population of Thailand was 67 million people in December 2009 (NSO, 2009a). According to the Agricultural Census in 2003, about 69 % of the people lived in rural areas. Around 34 % of all households throughout the country worked in agriculture and 93 % of them lived in rural areas. Total agricultural area in 2003 was 17.9 million ha (35 % of total area) whereof 94 % was located in rural areas with an average of 3.1 ha per household. The major activity on agricultural areas was cultivating crops (54 %) and integrated crop-livestock farming (35 %). Fifty-three percent of the cultivated area was used for rice cultivation, with the northeast region reaching 70 % (NSO, 2009b).

Thailand has been traditionally an agricultural-based country with a high proportion of the population being farmers in rural areas. Agricultural activities offer their major source of income and livelihood (Chantalakhana and Skunmun, 2002; Na-Chiangmai, 2002). Thailand has been a major exporter of agricultural products to countries all over the world (OAE, 2006). The country is renowned as a major rice producer and exporter to the world market. Rice is the major cash

crop besides cassava, corn and soybean. In the southern part of the country where the climate is more humid, rubber trees and oil palm trees are the main cash crops (Na-Chiangmai, 2002).

2.2 Agricultural and livestock production sectors

The agricultural sector has played an important role for the economy of Thailand throughout history. However, as the non-agricultural sector has been growing at a rapid rate during the past decade, the contribution of the agricultural sector to the Gross Domestic Product (GDP) declined steadily from 25 % during 1972 - 1976 to less than 10 % during 2002 - 2005 and only 8.3 % in 2007 (Thuvachote, 2006; OAE, 2008). Despite this development agriculture is still important as a large portion of the total land area is used by agriculture and about one third of the labour force in Thailand is employed by agriculture (Thuvachote, 2006). According to the 2003 Agricultural Census, most of the family members (more than 10 years old) were employed in agricultural activities (76 %), whereof 37 % depended only on agricultural activities and 39 % were employed in both agricultural and other activities. As a consequence, 79 % of the Thai households relied on income from both agricultural and other sources, whereof 40 % relied mainly on agricultural activities, and 21 % depended only on agricultural income (NSO, 2009b).

Within the agricultural sector itself, plants provided nearly 68 % of the GDP of the agricultural sector in 2007 while livestock contributed only a relatively small part (12 %; OAE, 2008). Livestock industries such as dairy and beef industries contribute an insignificant part to the Thai economy in terms of aggregated output. Moreover, the share has been declining (FAO, 2002; Na-Chiangmai, 2002; Thuvachote, 2006). However, the livestock industry is growing fast and plays an important role for the food production (Kehren, 1999; Sheepchaiisara, 2007). Thai farms are small-sized. Crop production on the farm can neither generate sufficient income for the families, which are usually big, nor can it provide full-time employment for all family members. Thus livestock production on a small farm usually plays a complementary role to crop production (Kehren, 1999).

The agricultural sector in Thailand has undergone a substantial transformation. It has shifted towards high valued products and non-traditional crops. Frozen chicken, sugar and canned

pineapples have become important, particularly for export markets (FAO, 2002). The livestock sector has been shifting from an integrated crop and livestock farming system to industrial livestock farm enterprises, but this development differs between livestock species. On the one hand, rapid growth has occurred in dairy, poultry, pig and duck production. Broiler, layer and pig are mainly produced for export markets and raised by large agribusiness companies (FAO, 2002; Na-Chiangmai, 2002). On the other hand, the importance of beef cattle and buffaloes is still low in spite of the fact that they are mostly owned by small farmers living in rural areas who account for 60 % of all Thai farmers, whereof almost 90 % are self-employed. These small farm households, whose living standard is mostly at the subsistence level, frequently operate an integrated farming system consisting of field crop horticulture, fishery and livestock farming (Kehren, 1999).

2.3 The status of beef cattle and buffaloes for agriculture in Thailand

Buffaloes and cattle have been an integral component of traditional agriculture in mixed crop-livestock farming systems since centuries. In Asia, buffaloes play a pivotal role for the overall social development (Chantalakhana, 2001; Nanda and Nakao, 2003). Economic importance of buffaloes and cattle to smallholders is generally underestimated especially because of their multipurpose contributions. Thereby, buffaloes and cattle ensure food security for the growing population and generate income of small-scale subsistence farmers (Indramangala, 2001). In the following the major roles of livestock in terms of their contribution to human needs are mentioned:

2.3.1 Food security

Food security can be defined as a combination of balance between availability and need, avoidance of temporary food shortage and nutritional deficiencies, and adequate food quality. Bovine animals are living manufacturers who transform non-edible feeds (such as crop residues, rice straw and weeds) into high protein food for human consumption. Thus, increased animal population may add to food security in several ways. First, many poor farmers will have direct access to more food with lower cost. Second, increased domestic production will reduce imports

and save foreign currency (Indramangala, 2001). Devendra and Thomas (2002a) stated that livestock contributes to food security and can alleviate seasonal food variability and availability. Animal products such as meat and milk are a primary source of proteins and amino-acids, and can be produced throughout the year.

In Thailand, beef for consumption is mainly from local cattle and buffaloes. The demand for red meat increases at a rate of 0.17 per year (Na-Chiangmai, 2002). In case of traditional ceremonies such as marriage, some religious rites and important traditional activities, rural farmers sell buffaloes or cattle for cash or slaughter them for meat. Moreover, in case of crop failure due to drought or flood, buffaloes and cattle will be sold in order to obtain sufficient cash income to purchase rice for year-round family consumption (Chantalakhana, 2001; Simaraks et al., 2003). Buffalo meat is very popular in countries where the buffalo population is high although it comes from culled animals or surplus males (Nanda and Nakao, 2003). Buffalo meat is becoming more important as an important source of protein in Asia since the demand for beef is increasing in most countries and beef supply from cattle cannot meet this rising demand. In Thailand, almost half of the beef supply is derived from buffaloes. Swamp buffaloes are not commonly raised for milk production due to their relatively low milking ability. For milk production usually river buffaloes are raised in South Asia (Chantalakhana and Skunmun, 2002).

In terms of natural food for human consumption, when livestock populations decline, natural food also does. Besides dung beetles living on livestock manure as a food source for farmers, certain wild fruit seeds regurgitated by livestock can be shelled and consumed as nuts by humans. Manure spread in natural water can fertilize and increase populations of aquatic life, such as various species of fish, crabs, aquatic insects, which can be turned into human food (Simaraks et al., 2003).

2.3.2 Insurance, capital and income generation

Insurance, capital and income generation of livestock is relevant for the socio-economic status of the farmers. Livestock can serve as long term capital reserve by using local natural resources as long as these resources are accessible without charge. Because variable annual rainfall, especially

in rain-fed areas, reduces income stability from cropping, rearing livestock as a means of a "saving bank" or a reliable "living bank" gives some financial security for emergency needs. In addition, sales of progeny or unproductive animals as an easily "convertible currency" and their dung provide direct cash income to the farmers and increase economic stability. Thus, animals represent buffer assets (with some security against inflation) which can be realized at any time, adding further stability to the self-sufficient crop-livestock system (Indramangala, 2001; Devendra and Thomas, 2002a; Nanda and Nakao, 2003).

In general, village farmers do not go to the bank since they live in remote areas and, after all, they do not have excessive cash to deposit in the bank. What they earn in cash is barely sufficient for their subsistence. While small animals offer a short-term or current saving account for daily petite cash needs, buffaloes and cattle serve as long-term saving or permanent saving account to provide bigger cash for very important family needs and as a source of inheritance from one generation to the next (Chantalakhana, 2001; Chantalakhana and Skunmun, 2002).

2.3.3 Integration into the farming system

Integrated farming systems are characterized by complementary and supplementary relationships between two or three commodities in the system. Diversification of agricultural commodities can help to reduce problems of market fluctuations and economic uncertainty. Mixed crop/animal farming systems have been practiced in a productive and sustainable way in developing countries for many centuries (Chantalakhana and Skunmun, 2002; Devendra and Thomas, 2002c). Buffaloes and cattle play a very important role in such systems in terms of the following aspects:

2.3.3.1 Farm power

In most developing countries, draught animal power remains an important source of farm power in spite of the increasing use of petroleum-based power. From the socio-economic point of view, these farming systems where draught power is still used, offer the highest benefit for the farmers, especially for those in rain-fed agricultural systems (Chantalakhana, 2001). Farm mechanization is suitable for several areas and different socio-economic frameworks, but for smallholders,

especially in the northeast region of Thailand, large ruminants, especially buffaloes are important when used as draught power for preparing paddy fields (Indramangala, 2001; Devendra and Thomas, 2002c). At present a large amount of rice production in the lowland rain-fed areas still depends on the use of draught buffaloes for land preparation, transportation, etc. The use of buffaloes for draught power is economically and socially suitable, especially when farmers live in remote areas, own only small parcels of land and family labour is available during the planting time (Chantalakhana, 2001).

Compared to mules and oxen, buffaloes with their strong body, broad hooves, flexible pastern and fetlock joints are well-suited to work on wet fields. They are widely used for all kinds of work in the rice cultivation, such as ploughing, harrowing and puddling rice fields, pumping water, and transporting. Termed as the "living tractor", both male and female swamp buffalo provide 20 - 30 % of the farm power in rice cultivating areas of South China, Thailand, Indonesia, Malaysia, the Philippines and Indochina (Nanda and Nakao, 2003).

2.3.3.2 Manure production

By the integration of cropping and livestock, farm wastes and crop by-products such as rice straw and weeds are efficiently used. It enables the transfer of nutrients to cultivated soils through the use of manure. Manure not only provides fertilizer but also improves the soil structure and pH value of the soil as well as promotes better absorption of moisture, reduces run-off and prevents crusting of the soil surface. The use of mineral fertilizers alone can decrease soil pH and base-saturation, and increase aluminium toxicity (Indramangala, 2001; Devendra and Thomas, 2002c). Farms producing crops alone are very dependent on external inputs (Devendra, 2002b). In Thailand, rice productivity remained on a stable level during the last three or four decades, while the use of chemical fertilizers has been minimal. Thai farmers in rain-fed areas have been using cattle and buffalo manure to maintain soil fertility. Manure is spread on paddy fields in the early rainy season and ploughed before rice planting (Chantalakhana and Skunmun, 2002). The transfer of nutrients from grazing lands to croplands through manure contributes considerably to the maintenance of soil fertility and the sustainability of these integrated farming systems (Devendra and Thomas, 2002c). For rural farmers the use of chemical fertilizer is too expensive

and riskful due to natural hazards and uncertainties such as drought, flood, or plant diseases and pests, as well as fluctuating market prices of paddy rice. Besides the use as fertilizer, manure is also been used for other purposes such as burning fuel and construction material (Chantalakhana and Skunmun, 2002).

2.3.3.3 Utilization of crop residues

Another important aspect of sustainable integrated farming systems practiced by rural smallholders is the utilization of crop wastes and by-products by ruminant animals. Crop production provides a range of residues and agro-industrial by-products (Chantalakhana, 2001; Devendra and Thomas, 2002c). Ruminants are known to digest such poor-quality roughages effectively, and in developing countries small farmers commonly use crop wastes and by-products to feed ruminants. In areas where buffaloes or other ruminants are not raised, crop residues are burnt. This is wasteful, creates pollution and sometimes causes serious accidents (Chantalakhana, 2001). By using these residues as feed for ruminants, the nutrients can be used effectively and contribute to the sustainable development of agriculture as well as animal production. Northeast Thailand is one of these regions where large amounts of crop residues are burnt without proper use. One of the main reasons for this is the decreasing number of native ruminants (Kawashima, 2002). Additionally, animals grazing the vegetation under tree crops such as rubber, oil palm, coconut and various fruits can control weeds and reduce the costs of herbicide use. These silvo-pastoral systems can lead to higher farm incomes and a more protected environment (Devendra, 2002a,b; Devendra and Thomas, 2002b,c).

2.3.4 Social and cultural supports

Livestock are closely linked to the social, cultural and religious lives of millions of resource-poor farmers, for whom the ownership of livestock ensures varying degrees of economic stability and agricultural sustainability (Devendra and Thomas, 2002a). Cattle and buffalo raising as part of small-scale agricultural systems has positive effects on the social and economic sustainability and consequently on the development of rural areas. Livestock plays an integral part for the family, and since only a small number of animals, especially buffaloes, are raised per household, farmers

take care of each animal (Chantalakhana, 2001; Indramangala, 2001). Large ruminants are usually looked after by women, the older generation and children, who are not employed otherwise. One of the major reasons for people in rural areas to choose to stay at home during the dry season is that they have to look after the animals (Chantalakhana, 2001; Indramangala, 2001). Moreover, buffaloes and cattle are part of many festivals as tourist attractions in Thailand. A very well-known example is the traditional buffalo racing and ploughing contest in Chonburi, an eastern province. An exciting event for foreign tourists is buffalo and cattle fighting in some provinces of southern region and there is an agrotourism known as “Ban Kwai Thai” in Chaing Mai province (Chantalakhana, 2001; Indramangala, 2001).

2.4 Husbandry of beef cattle and buffaloes in Thailand

In most parts of Thailand, especially in the northeast region, beef cattle and buffaloes are traditionally raised under extensive grazing systems (Kawashima, 2002). Village farmers, who generally raise a small number of ruminants usually use small areas besides crop field for grazing additionally to paddy fields after the harvest. In general, buffaloes and cattle depend mainly on rice straw and stubble, while other crop residues such as corn stalks, cassava and kenaf leaves, also provide substantial sources of roughage, especially during the dry season. When the cropping season begins during the rainy season, most of the land is used for rice or crop plantations. The animals are tied up for almost four months and fed only rice straw and/or cut and carried grasses, and/or are grazing tethered with no or low supplementation of concentrate or mineral supplements (Chantalakhana, 2001; Indramangala, 2001; Na-Chiangmai, 2002). In regions with poorer soils, less rainfall and only a small amount of irrigation; particularly in Northeast Thailand, traditional farming practices are used extensively. Generally the animals graze during daytime (edge of fields, roadsides, marginal land, communal grazing areas, etc.) and are kept in barns during night time where rice straw is fed (Indramangala, 2001).

Beef in Thailand is mainly produced by small-scale farms (Na-Chiangmai, 2002). The FAO (2002) reported that the average size of farms in northeastern Thailand has decreased. This reflects the fact that land availability for agricultural purposes is very limited due to increased population pressure and government policies that have reclassified some land into national parks

and other regions quarantined from further agricultural development. Most of the beef cattle and buffalo production can be characterized as backyard subsistence production in remote areas (Na-Chiangmai, 2002). There is a great variety in forms of husbandry and management techniques from region to region and even from farm to farm. These variations are a result of natural conditions of the grazing area, the crop production system, and the lifestyle and economic framework of the farmers. Knowledge about assessing the suitability for animal species of different environments has been passed through generations of farmers (Indramangala, 2001). The animals, particularly buffaloes, are produced under extensive conditions rather than in feedlot or intensive grazing (Khemsawat, 2003). They are generally kept in temporary housing (Na-Chiangmai, 2002) mostly only during the night for protection purposes. There are virtually no cash inputs used for animal production and most tending is done by family members (Chantalakhana, 2001; Chantalakhana and Skunmun, 2002).

Health care for buffaloes and cattle is minimal and vaccinations are rarely given except in case of a disease outbreak. A common infectious disease in bovine animals is foot-and-mouth disease (FMD) of types A, O, and Asia-1. *Haemorrhagic Septicaemia* is a very serious disease in buffaloes. Anthrax in cattle and buffaloes is not common. A small percentage of cows are found to be positive for brucellosis. In addition, internal parasites such as strongyloides and neoascaris are commonly found in buffaloes and cattle. In general, farmers do not buy any medicine to treat sick animals. They prefer to use traditional curing methods. Some herbs and medicinal plants are also available in villages (Chantalakhana, 2001; Chantalakhana and Skunmun, 2002).

2.5 Breeds and breeding systems

2.5.1 Beef cattle breeds

The beef cattle population of Thailand consists mainly of indigenous cattle and their crossbreds with several exotic breeds. The Thai indigenous cattle, classified as *Bos indicus*, have been associated with Thai people for an indefinite period of time (Intaratham, 2002). The body frame is small and the growth rate is low. They have been selected for survival under stressful environments. Thus they are highly adapted to these environmental conditions and their fertility

as well as the ability to use low quality roughages is high (Kawashima, 2002). The Thai native cattle are categorized in four ecotypes by area, i.e. Northeast, North (Khao Lamphun; Khao Lampoon), South and Central (Figure 2.1). There is no genetic information on the difference between the ecotypes (Intaratham, 2002). This classification is confirmed by a study of Akkahart (2003) by using phenotypic information of cattle kept on government farms. Four ecotypes of Thai native cattle were classified according their original region by using the clustering analysis with a 75 % coefficient of determination (R^2).

Northeastern ecotype

Northern ecotype (Khao Lamphun)

Central ecotype

Southern ecotype

Figure 2.1: Four ecotypes of indigenous cattle in Thailand

The prominent characteristics such as high fertility and ability to use low quality roughages of Thai native cattle have been overshadowed by the large body size of imported exotic breeds. As a consequence, the indigenous cattle have been neglected and crossed with zebu breeds (*Bos inducus*) such as Brahman (Figure 2.2) and others as well as several *Bos taurus* breeds. These were mostly imported into the cattle population as frozen semen of Charolais, Hereford, Simmental and Shorthorn for crossbreeding with the native cattle (Chantalakhana and Skunmun, 2002; Intaratham, 2002). The Thai government has been trying to increase the number of improved varieties of cattle such as Simbrah and Charbray since the authorities see these as being suitable for Thai conditions (FAO, 2002). In early 2001, the Department of Livestock Development (DLD) used many Brahman cow stocks to produce purebred and its crosses with exotic breeds. The "Tak" beef cattle breed (Figure 2.2) is a new synthetic breed of approximately 62.5 % Charolais and 37.5 % Brahman. An analogue is the "Krabinburi" beef cattle breed (50 % Simmental and 50 % Brahman) for dual purpose (Tongthainan, 2002). Moreover, Kasetsart University has developed the synthetic beef cattle breed called "Kamphaengsaen" (50 % Charolais, 25 % Thai cattle and 25 % Brahman; Figure 2.2) which has been widely accepted by local small-scale farmers and large beef farm enterprises in the central region (Chantalakhana and Skunmun, 2002).

The Indo-Brazilian (Indubrasil), a zebu cattle breed developed in Brazil, has been introduced to Thai farmers by some commercial farms more than 30 years ago. It was imported from the origin in Brazil to be promoted as a new cattle breed in Thailand. Compared to Brahman they have longer ears and a taller and larger body size (Oklahoma State University, 2009). These features were used to promote the animals as fashionable cattle and they have been quickly accepted by the farmers who expected higher prices when selling these fancy animals (very long ears, large and round head and specific coat colours; Figure 2.2.) through crossbreeding schemes. However, due to low muscling, low growth rate, low quality meat, high quality feed requirement and a high level of management needs compared to other breeds, there are a lot of controversial points of view of animal scientists and farmer organizations about the suitability of Indubrasil for the Thai beef production system (DLD, 2009).

Native-Brahman crossbred

Native-Brahman-Indo-Brazilian crossbred

Kamphaengsaen

Tak

Figure 2.2: Crossbred beef cattle in Thailand

2.5.2 Beef buffalo breeds

Of the two generic buffalo types, African (*Syncerus caffer*) and Asian (*Bubalus*), the latter has three species including anoa, tamarao and arni, of which only *Bubalus arni*, the Indian wild buffalo, was domesticated and named as *Bubalus bubalis* (Mason, 1974; Nanda and Nakao, 2003). Approximately 95 % of the water buffaloes (*Bubalus bubalis*) in the world are found in Asia and the Pacific region. More than half of them are found in India. In general, there are two breeding types of water buffaloes; the swamp type and the river type. Swamp buffaloes are raised mainly in China and Southeast Asia, whereas river buffaloes are found mainly in India and

Pakistan. The river buffaloes found in Europe and the Middle East are commonly referred to as the Mediterranean breeds. More than 70 % of the world's buffalo population are river buffaloes and swamp buffaloes only account for 30 %. The number of breeds of river buffaloes is high. Swamp buffaloes belong to only one breed in which different strains can be differentiated within the population of a country (Chantalakhana and Skunmun, 2002; Nanda and Nakao, 2003).

The buffaloes of Thailand are of the swamp breed. Within the swamp breed there are a number of strains whose characteristics are ill-defined. They occur in different localities, are accorded names, and are believed to have individual features of size, heat tolerance and horn conformation. *kwai tui*, *kwai kam*, *kwai jaam*, *kwai pra, marid, kwai glapp and kwai jawn* can be distinguished as local straits of Thai buffaloes (Cockrill, 1974). The swamp buffaloes are dark grey in common, but white or albinoid buffaloes can be found as well (Figure 2.3). The frequency of white buffaloes varies from 0 to 15 %. Grey coloured animals commonly have a white chevron (sometimes two) below the neck. In general, the horns are swept-back into semi-circles at the same height as the forehead (Chantalakhana and Skunmun, 2002). The variation in horn size is even greater – from very short horns like those of the European buffalo, to long straight horns curved only at the tip (Mason, 1974). The swamp buffaloes reach a mature weight at about 4 to 5 years of age. This varies from 450 to 650 kg for males, and from 350 to 450 kg for females (Chantalakhana and Skunmun, 2002). Swamp buffaloes are more suited to muddling and rice cultivation, and hence predominating in rice producing areas of South-East Asia (Nanda and Nakao, 2003). They have been part of Thai agriculture for many centuries. This animal has been the subject of natural selection for breeding, disease resistance and survival under natural conditions. They have adapted to the harsh environment of Northeast Thailand (Thummabood, 2002).

Thai swamp buffalo (dark grey)

Thai swamp buffalo (white)

River buffalo

Swamp-river buffalo crossbred

Figure 2.3: Breeds of buffaloes in Thailand

River buffaloes (Figure 2.3) are relatively well defined into several breeds. Most of them are found in India and Pakistan. Commonly, river buffaloes have curled horns and can easily be differentiated from the swamp type. A variation of horn-shapes is found. The best known breeds are Murrah, Nili-Ravi, Jafarabadi, Surti, Mehsana, Nagpuri, Egyptian and European (the Mediterranean) (Mason, 1974; Chantalakhana and Skunmun, 2002). River buffaloes have high lactation yields and the males are better suited as draught animals on dry land. This is the main reason for their predominance on the Indian subcontinent. Moreover, they are commonly found in the Mediterranean region of Europe, South America and the Caribbean mainly for milk and meat purposes (Nanda and Nakao, 2003).

Although swamp and river buffaloes share the same scientific name, the swamp type has 48 chromosomes (2n), while the river type has 50. The difference in chromosome number is due to a tandem fusion of the 4th and the 9th pair of the river type autosomes to be the first largest pair in the swamp type. Crossbreeding between these two types is possible and produces the offspring with 49 chromosomes (F_1) (Figure 2.3). The backcrossing of F_1 crossbreds to the swamp and to the river can also produce the offspring possessing 48 or 49 chromosomes respectively (Chantalakhana and Skunmun, 2002; Borghese and Mazzi, 2005).

2.5.3 National beef cattle and buffalo breeding programmes

Since 1975, the DLD of the Ministry of Agricultural Cooperatives (MOAC), Kasetsart University, Chulalongkorn University, Khon Kaen University and Rockefeller Foundation have developed a joint project to improve the buffalo production through breeding selection. It is named "The National Buffalo Research and Development Centre Project" (Indramangala, 2001; Chantalakhana and Skunmun, 2002). There have been various activities carried out both at a national and international level. Establishment of an information centre called the "International Buffalo Information Centre" (IBIC) and the formation of the Asian Buffalo Association (ABA) were included (Indramangala, 2001). The breeding programme, however, was only partly implemented until 1980 when a performance testing programme was implemented. A closed nucleus breeding herd was kept at government stations. The breeding objective, established since 1981, was to increase the growth rate and the body size (Indramangala, 2001; Chantalakhana and Skunmun, 2002).

Since 1996, the Australian Centre for International Agricultural Research (ACIAR) has introduced a new technology for the genetic evaluation of the animals under the project "Genetic Improvement of Thai Beef Cattle and Buffalo". The Thai BREEDPLAN software has been programmed to analyze data recorded since 1991, to identify superior animals and to define the genetic and phenotypic trends over years. Estimated Breeding Values (EBV) of animals were obtained from the analyzing using Best Linear Unbiased Prediction (BLUP) methodology in a multi-trait animal model for across-herd evaluation. Beef cattle and buffalo estimated breeding values in various traits have been used to select genetically superior animals for breeding and to

develop appropriate strategies for maximizing the use of these superior animals (Na-Chiangmai, 2002; Vitoonpong and Rush, 2002).

Many projects by various research institutes aimed at improving the productivity of beef buffaloes and cattle. Socio-economics have been taken into account as beef buffaloes and cattle are classified as part of the farmers' tradition and rite. An open nucleus breeding scheme (ONBS) has been introduced. The farmers are requested to record basic data of their animals and are advised by DLD officers. Data collected at the village level are collected in a central database and analyzed using the Thai BREEDPLAN genetic evaluation system (Na-Chiangmai, 2002). The DLD is now expanding the system and also includes data of the on-farm trial breeding project. This will assist government farms in producing superior genetic parent stock that performs well under small-scale farming conditions. However, the participation of the farmers in the breeding programme is too low and breeding and selection are conduced under governmental auspices only (Thummabood, 2002). Chantalakhana and Skunmun (2002) stated that due to the lack of an effective national beef cattle and buffalo breeding improvement programme over a long period, the appearance of declining genetic quality of the animals in Thailand occurred.

2.5.4 Breeding systems in small beef cattle and buffalo farms

In Thailand the buffalo population is dominated by only one breed, Thai swamp buffaloes, whereas the cattle population is made of indigenous breeds and their crossbreds with several exotic beef breeds (Intaratham, 2002). Crossbreds between Thai Native and Brahman cattle can be found in many areas due to the promotion of Brahman bulls by the DLD during the last two or three decades. These crossbreds are well-adapted to the Thai environmental conditions are widely accepted by the farmers. Some farmers raise high grade or even purebred Brahman. Brahman and their crossbreds are generally priced much higher per kg than buffaloes or indigenous cattle. Purebreeding is commonly practiced with buffaloes (Chantalakhana and Skunmun, 2002).

Beef cattle and buffalo breeding on small-scale farms is generally random mating. During the planting season, the animals that are confined for almost four months are not available for mating. They are grazing together in the paddy fields after the harvest season when mating

occurs. In some areas, where large paddy fields are available during summer, the number of females in a cumulative herd may be up to 30 - 50 heads with few bulls roaming together. Small-scale farmers do not maintain a breeding bull since the number of breeding cows per farm is very low (Na-Chiangmai, 2002). Only a small number of buffalo farmers keep a breeding bull and traditionally the male buffaloes are castrated in order to simplify the handling and to avoid fighting among them. Artificial insemination (AI) in buffaloes is limited while it is quite successful in cattle, especially when exotic breeds are used (Chantalakhana and Skunmun, 2002; Na-Chiangmai, 2002). Selective breeding, except crossbreeding, has not been practiced by small-scale farms. Heifers for replacement are usually produced within the farmer's herd and the purchase of breeding cows is quite rare (Chantalakhana and Skunmun, 2002).

During the past four or five decades, the introduction of exotic breeds, dairy as well as beef breeds, into developing countries in Asia has been widely practiced by national governments in order to upgrade the productivity of local indigenous breeds. In Thailand, exotic breeds, both *Bos ta*urus and *Bos indicus,* have made significant impacts on beef improvement. This import together with unplanned crossbreeding of Brahman cattle with indigenous cattle, has threatened some well-adapted local breeds such as the Khao Lamphun cattle of the North of Thailand and the indigenous cattle of the Northeast. Without long-term conservation and management schemes supported by the government, these breeds are likely to disappear just in the same way as the local pig breeds which are now practically extinct after three decades of introduction of exotic breeds and crossbreeding programmes initiated by the government (Chantalakhana and Skunmun, 2002).

2.6 Social and environmental issues in beef cattle and buffalo farming

During recent years, public concern about the impacts of animal production on human well being and the environment has risen in Thailand (Chantalakhana and Skunmun, 2002). When raised in densely populated villages, problems with livestock and its manure will arise (Simaraks et al., 2003). Livestock have been accused of causing degradation of natural resources such as land and forests, as well as pollution and global warming. Undoubtedly, animal production partly contributes to these problems, but the allegations against livestock are often exaggerated or

unfounded (Chantalakhana and Skunmun, 2002). Heavy pressure of livestock without appropriate management on grazing land leads to overgrazing and consequently increases soil erosion and land degradation. On the other hand, well-managed animal production will not cause these pressure on natural resources and beyond this may enhance the quality of the natural resources while generating food and income (Chantalakhana and Skunmun, 2002; Devendra, 2002b).

In mixed farming systems, it has been generally recognized that the interactions between crop and animal components produce several favourable impacts on natural resources and the quality of the environment. Manure not only maintains soil fertility but also adds organic matter and improves soil structure and water-holding capacity (Chantalakhana and Skunmun, 2002). This system also provides many opportunities for nutrient recycling and organic farming and diversifies the structure of the landscape (Devendra, 2002b). Furthermore, there is evidence of economic benefits of crop-animal interactions that promote a sustainable agriculture and the protection of environmental resources (Devendra, 2002a). Devendra and Thomas (2002c) mentioned that the introduction of improved forage species for ruminants increases the sustainability of cropping systems. In addition to their feeding value, which is well documented, improved forages (particularly legumes) can make an important contribution to erosion control by providing cover, and to increased soil fertility by enhancing nutrient and organic matter levels.

Nanda and Nakao (2003) reported that an enormous amount of available fibre-rich by-products of cereals would lead to serious environmental pollution, if they are burnt. Buffaloes can convert these agro-industrial by-products into meat, milk and manure, and thereby prevent environmental pollution. Furthermore, buffaloes balance the growth of several kinds of flora and fauna while grazing in wetlands.

For the farmers, animal production is a risk aversion in case of crop failure, but on the other hand a saving. Livestock are used as inheritance and for curtailing the limits of poverty. Animals have social, cultural or religious functions in many societies. For example, in many Southeast Asian societies, large ruminants and pigs are cooked during ceremonies to pay respect to ancestors. Sheep and goats are used as food in religious ceremonies by Muslims and bull fighting and

buffalo raising are very popular in several countries (Chantalakhana, 2001; Chantalakhana and Skunmun, 2002; Nanda and Nakao, 2003).

2.7 Competition between buffaloes and cattle

In the former time, Thai small-scale farmers who practiced mixed farming systems usually kept both buffaloes and cattle. Besides the complementary characteristics of buffaloes and cattle, both from biological and socio-economic aspects, other reasons played a role. Cattle were raised for sale and buffaloes for draught power as well as for sale (Chantalakhana, 2001). Nowadays buffaloes are no longer kept for draught power and only for beef production (Na-Chiangmai, 2002). Because both cattle and buffaloes are relying on the same farm resources, buffalo and cattle farming is competing with each other, whereas cattle farming is usually preferred by Thai farmers (Skunmun et al., 2001).

Scientists point out that it is inappropriate when the productivity of buffaloes and exotic cattle breeds such as Brahman is compared. Because of their low growth rate, late maturity and long calving interval buffaloes are inferior, but other studies have indicated that their productivity is remarkably high, compared to exotic cattle breeds when they are kept under the same harsh conditions (Indramangala, 2001). Buffalo infertility has been noted as a major concern. Moreover, it is usually caused by mismanagement, e.g. the lack of bulls or the failure of farmers to give productive females a chance to mate. Moreover, feeding strategies and behaviour is important in assessing the suitability of animal species to different environments. Among others, the suitability is depending on morphology and physiology characteristics associated with diet selection and the rate of passage of fodder through the digestive system (Indramangala, 2001). When buffaloes and cattle are being raised under the same conditions with management and feeding levels being low, the productivity, expressed as growth rate, meat quality and fertility, is comparable (Chantalakhana, 2001). Due to wallowing, buffaloes are less susceptible to ticks than Brahman cattle, but their lower number of sweat glands on the body skin, they are less heat tolerant than zebu cattle (Chantalakhana, 2001).

It is well known that buffaloes are digesting fibre and cellulose more effectively under harsh conditions than cattle. Buffaloes are much more productive when roughage feeds become scarce during the dry summer season since they are less selective in grazing and have wide muzzles (Chantalakhana, 2001). Buffaloes eat a wide variety of feed. It is known that they graze under water (Tulloch, 1974). Large gut capacities and a greater degree of fermentation in the buffalo rumen when compared to cattle, result in a slow passage rate and thus in a higher production of microbial protein (Indramangala, 2001; Bartocci et al., 2005). Poondusit (2001) reported that the numbers of rumen bacteria and fungal zoospores in buffaloes are significantly higher than in dairy and beef cattle, while protozoa were significantly less. In addition, the value for ammonium nitrogen in buffaloes was higher as a consequence of higher production of microbial protein. These mean a higher efficiency to utilize high cellulose forage such as crop residues.

As swamp buffaloes have been utilized as draught animals, relatively large and powerful animals have been selected by farmers. In contrast, Thai native cattle have been raised under more extensive conditions. The cattle were not selected in favour of their suitability as draught animals. For cattle characteristics, such as adaptability to low quality feed, resistance to disease, and fertility were used to select superior animals (Kawashima, 2002). Furthermore, buffalo meat is lean, tasty and often undistinguishable from beef. It contains lower saturated fat than beef and pork, which is a benefiting human health. Buffalo meat contains 40 % less cholesterol, 55 % less calories, 11 % more protein and 10 % more minerals in comparison to bovine meat (Nanda and Nakao, 2003).

2.8 Government incentives and policies for beef cattle and buffalo production

Several activities aiming to increase the beef cattle and buffalo production initiated by the Thai government are summarized in the following.

2.8.1 Cattle and Buffalo Banks

The “Royal Initiated Cattle-and-Buffalo Bank Project” was initiated as early as 1978 when His Majesty (H.M.) the King of Thailand visited Prachin Buri province and saw small farmers’

suffering of the serious shortage of draught buffaloes for farming. The project aimed at providing draught animals and H.M. the King once described the project as the collection and distribution of the animals in order to help those who do not have livestock for farming (Chantalakhana, 2001). The recent aim of this project is to donate the animals to the poor who do not have animals for draught power and as a consequence increase the number of progeny from these animals and pass them on to other farmers. The fund is established from donations and administered under DLD management (Indramangala, 2001).

2.8.2 Promotion of buffalo conservation and development villages

In order to restore the interest of villagers for buffalo raising, government agencies responsible for buffalo development have to promote the importance of buffaloes in rural areas, improve farm productivity and lower the cost of production. In 2000, the DLD initiated this project in 19 villages of 19 provinces in northeastern Thailand. The major objectives of the project are: to encourage voluntary participation of rural farmers to find solutions for livestock production problems, to reduce the decline of the buffalo population, to create awareness among farmers of the importance of buffalo for the sustainability of the mixed crop-livestock farming systems in the northeast region, to make the village a centre for livestock technology transfer to farmers in other villages and to promote the conservation and sustainable development of buffalo production (Chantalakhana, 2001; Indramangala, 2001; Koobkaew and Wanapat, 2001).

2.8.3 Village Buffalo Emergency Fund

It is generally known that buffaloes are a long-term saving and asset of rural farmers. In case of urgent need of money, farmers usually depend on the sale of buffaloes. Some farmers sell buffalo cows to buy fertilizer for crop production. The sale of buffalo cows can be prevented if a village buffalo emergency fund could be set up to offer emergency loan by using buffalo cows as collateral. The farmer can obtain cash up to half of the value of the buffalo cow. The value of a buffalo is determined by a certain committee. The farmer keeps the “pawned” buffalo cow and the farmer can pay back the loan within the following year. If the pawned cow produces a calf

during the loan period, the calf belongs to the farmer. This approach aims to slow down the sale of buffalo cows and to increase the number of buffalo calves (Chantalakhana, 2001).

2.8.4 Beef cattle farm promotion in northeast region

In 1989, the Thai government launched a programme in order to promote beef farm enterprises in the northeast region by providing commercial-grade Brahman cattle imported from Australia for the farmers who were offered loan credits for farming operation through the government's Bank of Agriculture and Agricultural Cooperatives (BAAC). Unfortunately, due to the infertility of cows and a decline of the beef price the farmers refused to continue to keep cattle and returned all animals to the government (http://www.thaicow.org/cp05.htm; http://www.thaicow.org/cp07.htm ; http://www.thaicow.org/yco06.htm; Juntip et al., 1995; Markvichitr et al., 1995; Tumwasorn et al., 1995, 1996a,b; FAO, 2002).

2.8.5 One million beef cattle households promotion

Although the previous mentioned programme failed, the beef cattle raising promotion for one million households throughout the country was renewed by the DLD (during 2004 to 2007). However, due to a lot of technical and management problems in arrangement of beef cattle provision for the farmers and disagreement from scientists and farmer organizations, the project failed as well (http://media.thaigov.go.th/pageconfig/viewcontent/viewcontent1e.asp?pageid=472 &directory=1943&contents=8672; http://www.thaicow.org/cp28.htm; http://www.thaicow.org/yc o17.htm).

Indramangala (2001) and Thummabood (2002) agreed that the promotion of beef production in Thailand was unsuccessful especially for buffaloes; the population has declined significantly. Chantalakhana (2001) reported that some government policies, such as the promotion of farm mechanization, the promotion of beef cattle raising, the lack of fair and effective marketing systems for rural farmers, the weak law enforcement concerning illegal slaughter of animals, etc. have contributed to the decline of the buffalo population in Thailand during the last two decades.

2.9 Situation of beef cattle and buffalo production in Thailand

Thai livestock farms are small in terms of farm area and herd size with an average number of 4.8 buffaloes and 6.8 beef cattle per household in 2008 (DLD, 2008b). More than 74 % of the buffaloes and 54 % of the beef cattle can be found in the northeast region (DLD, 2008b) (Table 2.1), where the beef animals are mainly raised in small villages (Khemsawat et al, 2003). Between 1999 and 2008 the number of beef cattle increased from 4.6 to 9.1 million head while the number of buffaloes declined from 1.8 to 1.4 million head (DLD, 2008a), showing a trend of transition from buffalo rearing to cattle farming enterprises (Skunmun et al., 2001).

Table 2.1: Number of beef cattle and buffaloes in each region of Thailand during 1999 to 2008

Number of beef cattle, head					
Year	Central region	Northeast region	North region	South region	Total
1999	855,232	2,219,437	875,403	685,669	4,635,741
2000	849,237	2,522,961	943,251	585,165	4,900,614
2001	1,022,264	2,573,233	1,025,750	606,357	5,227,604
2002	936,075	2,910,823	1,132,292	570,995	5,550,185
2003	984,069	3,078,149	1,297,460	556,645	5,916,323
2004	1,001,425	3,693,782	1,326,987	646,138	6,668,332
2005	1,296,820	4,092,206	1,636,851	770,395	7,796,272
2006	1,315,270	4,316,949	1,564,797	839,041	8,036,057
2007	1,516,298	4,501,769	1,953,406	876,919	8,848,392
2008	1,553,668	4,931,389	1,847,601	779,435	9,112,093
Number of buffaloes, head					
1999	97,879	1,503,176	151,134	47,417	1,799,606
2000	98,968	1,406,442	151,829	44,984	1,702,223
2001	104,415	1,413,697	149,856	42,127	1,710,095
2002	102,263	1,317,540	163,953	33,602	1,617,358
2003	114,562	1,316,530	168,526	33,088	1,632,706
2004	97,572	1,215,531	153,211	27,923	1,494,238
2005	130,609	1,241,766	220,610	31,934	1,624,919
2006	100,818	1,046,678	171,742	32,613	1,351,851
2007	129,866	1,175,826	225,970	46,136	1,577,798
2008	112,133	1,010,913	205,815	30,946	1,359,807

Source: DLD (2008a)

There has been a sharp decrease of the number of buffaloes and possible genetic erosion due to heavy slaughtering and exploitation (Indramangala, 2001). During the past few years the increasing rate of slaughtering of pregnant buffalo cows have reached a critical level which will bring this animal closer to extinction (Chantalakhana, 2001). The major reasons for the decline of the buffalo population include promotion of the government for mechanization using two-wheel tractors instead of buffalo power, socio-economic changes to adopt modernization of agricultural production, lack of proper attention by the policy makers and the researchers and price differences between prices of live buffalo and cattle (Chantalakhana, 2001; Indramangala, 2001; Chantalakhana and Skunmun, 2002; Nanda and Nakao, 2003). Chantalakhana (2001) mentioned that in spite of the contributions buffaloes have made to the farming systems in rural areas, they are a neglected animal species in terms of government and private investments. Almost all of the buffaloes belong to resource-poor farmers who have little or no influence on government or administrative decisions, while large government livestock development programmes are usually influenced by external assistance experts with no interest in buffaloes and no real understanding of traditional small farmers who usually have little or no education and are easily influenced by government policies carried out by local officials.

In most developing countries in Asia commonly national government policies in relation to livestock development are lacking or have a negative or weak impact on livestock development. Livestock service and extension programmes are mostly inefficient and inaccessible by small farmers. Control and prevention of important infectious diseases such as FMD have been unsuccessful. FMD has become the most important disease that creates trade barriers for international livestock trade of ruminants and pigs. Most developing countries in Asia never had long-term livestock development strategies and plans. Questions like livestock zoning in order to promote efficient management of animal wastes, health control, product processing and marketing systems are still not answered. Research for development of animal production is mostly lacking in infrastructure, personnel and competency (Chantalakhana and Skunmun, 2002; FAO, 2002). It is required that the government provides a clear policy and financial support to public institutions to increase their activities concerning livestock research for development and appropriate policies (Chantalakhana, 2001).

CHAPTER 3

MATERIALS AND METHODS

Materials and Methods

3.1 Study area

This research was conducted in the province of Nakhon Ratchasima (also known as: Korat or Khorat), located in the southern part of northeastern Thailand (between 15 ^{o}N and 102 ^{o}E). The province consists of 32 districts with a total area of 20,494 km^2, and is the biggest province of the country (Figure 3.1). Annual average daily temperature is 27.4 ^{o}C with an average humidity of 71 %, and annual average rainfall is 1,019 mm. A cool (November to February), a hot (March to May) and a rainy season (June to October) can be distinguished. The province is located on the western end of the Khorat Plateau, and is separated from the Chao Phraya river valley by the Phetchabun and Dong Phaya Yen mountain ranges. It consists mainly of plateaus and mountainous terrain. Two national parks are in the province - the Khao Yai in the west and the Thab Lan in the south (Nakhonratchasima, 2008).

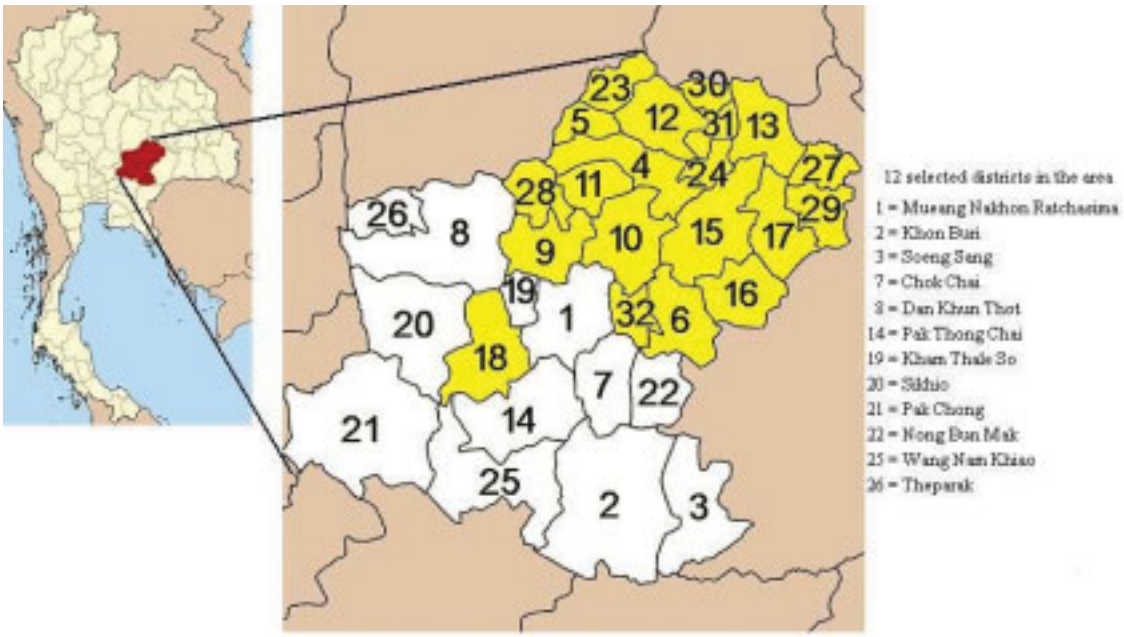

Figure 3.1: Map of Nakhon Ratchasima province, northeastern Thailand showing 12 selected districts (white in colour) (mod. by Nakhonratchasima, 2008)

Of all provinces in Thailand, Nakhon Ratchasima province has the largest agricultural area, the largest number of farms and the highest average farm size per household (4 ha). The people are solely dependent on agricultural activities for their livelihoods. The declining soil fertility, the lack of water and a large number of saline areas (30 % of total areas) are frequently identified as major constraints for high potential crop production. Rain-fed cropping such as rice, cassava, sugarcane, corn, fruits etc. is the main agricultural activity. Beef cattle and buffalo raising is extensively practiced and depends on natural grasslands and mountain areas (Nakhonratchasima, 2008).

3.2 Selection of farms

The multi-state sampling method was used to select the farms for the study. Data from the national census of the livestock sector in 2006 obtained from the Nakhonratchasima Provincial Livestock Office, DLD, was compiled to characterize the production systems of beef buffaloes and beef cattle, and served as a sample frame for selecting target farms in the area. Based on this data those districts with farms that had an average number of more than 10 either beef buffaloes or beef cattle per farm were selected out of the 32 districts. After this, the target farms were classified from the list of the livestock farms in the selected districts based on the number of cows: (1) < 6 as small-scale, (2) 6 to 20 as medium-scale and (3) > 20 as large-scale. Only farms with a traditional cow-calf production system were selected. Another prerequisite was that livestock was kept for at least 5 years. In case that the selected farmers could not be identified or their characteristics diverged from the sample frame, other farmers were selected either by the snowball technique or by asking residents or people on the street to identify owners of livestock observed on fields. Each of the farm size classes contained 19 to 22 farms (n = 121). The 12 selected districts were Mueang Nakhon Ratchasima, Khon Buri, Soeng Sang, Chok Chai, Dan Khun Thot, Pak Thong Chai, Kham Thale So, Sikhio, Pak Chong, Nong Bun Mak, Wang Nam Khiao and Thepharak (Figure 3.1).

3.3 Study methods

A single-visit, multiple-subject survey was carried out between October 2007 and May 2008 using face-to-face interviews. The recall, observation and measurement method was used to complete a pre-tested, semi-structured questionnaire. The opinions and views of the farmers were gathered by open-ended questions. Information obtained from each farm covered:

1. Information about farm household included household status, family members and household head information, land holdings and land use as well as household activities. Livestock farm characteristics were collected including farm labour management, use of livestock manure, sources of livestock and husbandry experience.
2. Information about livestock husbandry was divided into feed resources and feeding systems, herd structure, breeding practices and farm practices.
    a. Feed resources and feeding systems included data such as feeding management, cultivation and utilization of pastures, and area allowances for the animals. Area allowance based on agricultural and cultivated pasture lands (ha per TLU; TLU = Tropical Livestock Units: 1 for bulls; 0.7 for cows; 0.5 for heifers and young bulls; 0.2 for calves, Bebe et al., 2003) were calculated. Sources of main forages throughout the year were ranked by the farmers according to their importance (the lower the rank, the more important). Furthermore problems of these resources, feed supplementation and its limitation, and supply of green forage throughout the year were investigated.
    b. The herd structure of the farms was characterized based on the following: mature males (more than 3 years), castrated males, young males (post-weaned to 3 years), cows (after first calving), heifers (post-weaned to first calving), male and female calves (pre-weaned) according to Bebe et al. (2003). The demography of the livestock herds (births, deaths, giving, receiving, sales, purchases and exchanges) over the previous 12 months and breed compositions of the herds were recorded. Besides this information on breeding services, sources of replacement stocks, breeding objectives and selection traits were observed.

c. Information about livestock farm practices included housing, farm facilities and farm management.

3. The importance of the livestock was evaluated on data including reasons for keeping the animals, role of livestock in unplanned and planned expenses during the past 5 years, household subsistence, dwelling conditions, household assets and access to health insurance.

4. The farmers were asked to compare favourable traits of buffaloes and cattle, and to give their ideas of reasons for the decreasing buffalo population. Impacts of livestock farming on environment and community during the past 5 years, and farm production constraints and needs cited by farmers were determined.

3.4 Data analysis

Descriptive statistical analysis was applied to describe the characteristics of beef buffalo and beef cattle production systems in this area. The analysis of variance (ANOVA) was used to analyze the numeric data. Because of unbalanced data sets, GLM procedure was used to explore the main and interaction effects and Least-squares means were calculated for each effect and used to determine differences between beef buffalo and beef cattle farms as well as between small-, medium- and large-scale herds at a significance level of $p < 0.05$. The Fisher's Exact and Chi-square (χ^2) tests were applied for the categorical data. The correlation analysis was used to describe the relationship between numeric variables by using Pearson correlation. The level of agreement between groups was assessed using Kendall's coefficient of concordance (W). W ranges from 0 to 1 and the higher its value the greater is the level of agreement between groups or individuals. The data were analyzed using the Statistic Package for Social Sciences SPSS-PC Version 15 (SPSS Inc., 1999).

CHAPTER 4

A comparison of characteristics, socio-economic benefits and household livelihood impacts of beef buffalo and beef cattle farming in northeastern Thailand

Chakrapong Chaikong, Jan Maxa, Eva Schlecht and Matthias Gauly

A comparison of characteristics, socio-economic benefits and household livelihood impacts of beef buffalo and beef cattle farming in northeastern Thailand

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4.1 Abstract

Since the Thai economy experiences rapid growth, agriculture has been shifting more towards non-traditional products. On account of these changes, buffaloes and cattle should be re-examined for their productions and roles to farm households in order to initiate suitable development programmes. This end, 121 beef buffalo and beef cattle farms in Nakhon Ratchasima province, northeastern Thailand were interviewed by using a semi-structured questionnaire between October 2007 and May 2008. Both species were mostly integrated in mixed crop-livestock systems with small farm size (7.9 ha) whereof less than half was used for the livestock. Family members were essential for farm activities while salaried employees were only found at large herd farms. The most important reasons for keeping the animals were income earning related to accumulate wealth or savings (22 %), expected (19 %) and unexpected (19 %) expenses covering, regular main (11 %) and additional (9 %) sources of income earning. The improvement of social status (18 %) was also important. Only 2 % of the farmers kept the animals for draught power, inheritance, manure and conservation. Most of the planned and unplanned expenses of households during the last 5 years were covered by selling the livestock (58 %) and other farm products (19 %). Farms with larger herds showed better dwelling conditions, more household assets and more access to commercial health insurances. Buffaloes and cattle can clearly cope with almost all household economic needs and improve farmers' socio-economic status and livelihoods substantially. This importance should be more considered and incorporated into the livestock development programmes.

Keywords: Farming systems, Livelihoods, Livestock roles, PRA, Socio-economy

4.2 Introduction

Since the mid 1990s, the Thai economy has experienced rapid growth. The agriculture sector has been shifting towards high valued products and non-traditional crops. The importance of chickens, pigs and ducks rapidly expanded in terms of agricultural business. While the number of cattle gradually increased, the importance of buffaloes, which mostly are of the swamp type continuously declined (FAO, 2002). Most of buffaloes and cattle are kept by smallholder farmers and integrated in a mixed crop system. Such integrated farming systems are mainly practiced in order to generate adequate income, provide food security for family members as well as manage and conserve the natural resource base for sustainable agricultural production (Devendra, 2000; Devendra and Thomas, 2002b; Na-Chiangmai, 2002). Most of the livestock farms are small in terms of land area and also in terms of herd size with an average number of 4.8 buffaloes and 6.8 beef cattle per household in 2008. More than 74 % of buffaloes and 54 % of beef cattle can be found in the northeastern region, where the production system for beef animals centres mainly on the local villages (DLD, 2008b). The beef animals are mainly raised under extensive grazing and crop residue feeding. Farmers generally kept the animals in temporary housing in the back yard. There were virtually no cash inputs and most tending was done by family labour including women, children or older persons (Chantalakhana, 2001; Na-Chiangmai, 2002).

Whereas buffaloes and cattle were mainly used for working in crop fields in the former times most animals were progressively being replaced for their draught power by machinery except in rain-fed low land areas where farm machinery can hardly be used. Consequently, many farmers no longer raise the animals for working but rather for beef production and as part of their tradition. Livestock dung has been used to maintain soil fertility in rice production, and excess animals were sold when necessary for extra household income and unexpected expenditures; otherwise, they fulfilled the strategic purpose of a saving bank. There has been a trend of transition from buffalo rearing to beef cattle farms as a result of competition for farm resource use between both animals. Moreover, Thai government has promoted beef cattle farm enterprises for many years but the promotion for buffalo keeping has just started in terms of conversation programmes. This resulted in a decline of the buffalo population and a retardation of development of the livestock production (Chantalakhana, 2001; Khemsawat et al., 2003; Nanda

and Nakao, 2003; Simaraks et al., 2003). Given the current changes in livestock production systems, there is need to clarify the effects of such developments on farmers' livelihoods by inter-disciplinary and community-based participatory approaches (Devendra, 2002a). This study therefore investigated the present characteristics of beef buffalo and beef cattle farming systems in northeastern Thailand and its benefits for the local farming communities.

4.3 Materials and Methods

See Chapter 3

4.4 Results and discussion

4.4.1 Farm household characteristics

The characteristics of 121 beef buffalo and beef cattle farm households in northeastern Thailand are shown in Table 4.1. The majority (89 %) of farmers who kept the animals were male and aged on average 56.3 years (range 28 - 80 years). Farmers keeping beef buffaloes were significantly ($p<0.05$) older (58.8 years) than beef cattle farmers (53.7 years). The education level of the farmers in the studied area was primary school only, visited by 86 % of the respondents, and there were no significant differences in the literacy level, neither between beef buffalo and beef cattle keepers nor between large, medium and small size livestock farmers. Thai people spend only a few years of their life on education, especially in rural areas (ONEC, 2001). According to data from official population and household census, people aged $\geq$ 6 years who had primary level education constituted 68 %, 72 % and 70 % of the population in 1970, 1980 and 1990, respectively (NSO, 2008). Satchaphun et al. (2006), who studied 142 beef buffalo keepers in southern Thailand, found that most of farmers were male (82 %) and mainly (73 %) between 31 and 60 years old. Most of farmers in this region had finished primary school (75 %), but some had also visited middle school (21 %) or high school (2 %), and only 0.7 % had not visited any school.

Nearly half (43 %) of the studied farms had received the livestock from their ancestor as an inherited asset (Table 4.1). The farmers who kept a large number of animals had mainly inherited the livestock from their parents, with significant difference ($p<0.05$) compared with smaller-scale herd farms. Furthermore, the large-scale livestock keepers had a longer experience ($p<0.05$) in livestock farming (27.7 years) than the small-scale (21 years) and medium-scale (19.9 years) livestock keepers. Ranging from 5 to 62 years, the average time-span of livestock experience of farmers in the study region was 22.7 years, indicating that beef buffalo and beef cattle rearing are generally in the hands of elderly people with long-term experience. The age of farmers was positively correlated with their husbandry experience ($r=0.46$, $p<0.0001$). Satchaphun et al. (2006) reported that the average time-span of livestock experience in beef buffalo farmers was 12.6 years (rang 1 - 70 years) in southern Thailand. Beef buffaloes and beef cattle are considered by rural farmers as a long-term investment and an asset of inheritance from one generation to the next (Chantalakhana, 2001; Simaraks et al., 2003).

Most of the household heads (93 %) were male and had an average of age around 58.6 years (range 36 - 80 years), whereby family heads keeping beef buffaloes were older than family heads keeping beef cattle (61 against 57 years, respectively, $p<0.05$). In the majority of households (87 %) the - male - household head looked after the animals, whereby this value amounted to 90 % in beef buffalo farms and only 83 % in beef cattle farms. According to a farm households survey in northern Thailand in late 1994, men constituted a significantly higher proportion of the workforce (64 %) than women (36 %), and the main responsibility for caring for animals was predominantly with male community members (Kehren, 1999). Grünbühel et al. (2003) mentioned that the head of family in northeastern Thailand is usually the oldest and most respectable person and has the first priority to take decisions within the family, with priority being given to the male members. NSO (2008) reported that women were not usually nominated as household head unless they were alone or if there were no adult men in the household.

Self-employment in agriculture was the main occupation of household heads (87 %) in this region, the responsibilities being the care for their livestock and the cropping activities. The average family size was 4.4 persons, varying from 1 to 10 (Table 4.1). The average work force per family was 2.8 persons, ranging from 1 to 6, whereby the number of family members and the

number of family workers was strongly correlated (r=0.68, p<0.0001). The number of family members and family workers, respectively, did not differ significantly between beef buffalo and beef cattle farm households or small, medium and large size holdings. Studying the multi-functionality of integrated farming systems in one community in Khon Kaen province in northeastern Thailand, Tipraqsa et al. (2007) determined an average household size of 5 and 4 persons for integrated farms (multiple objectives) and commercial farms (market-oriented rice production), with labour force (persons aged 15 - 65 years) being 4 and 2 persons, respectively.

Table 4.1: Characteristics of 121 farm households keeping beef buffaloes and beef cattle in northeastern Thailand, as determined during October 2007 to May 2008

Farm household parameters	Beef buffalo herds			Beef cattle herds		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Farmer gender, %						
Male	95.5	90.0	84.2	75.0	90.0	100.0
Female	4.5	10.0	15.8	25.0	10.0	0
Farmer age, years (SE) [a]	59.4 (2.3)	59.4 (2.4)	57.5 (2.5)	54.1 (2.4)	53.6 (2.4)	53.5 (2.4)
Farmer education, %						
Illiterate	9.1	5.0	5.3	5.0	5.0	10.0
Literate but no school	4.5	0	0	5.0	5.0	0
Primary school	86.4	90.0	89.5	80.0	90.0	80.0
Middle school	0	5.0	0	5.0	0	5.0
High school	0	0	5.3	5.0	0	5.0
Animal inheritance, % of farms [b]	31.8	50.0	63.2	35.0	20.0	57.9
Farm experience, years (SE) [c]	24.3 (3.1)	19.8 (3.2)	31.1 (3.3)	17.5 (3.2)	20.0 (3.2)	24.3 (3.3)
Family members, n (SE)[1/]	3.9 (0.4)	4.0 (0.4)	4.6 (0.4)	4.4 (0.4)	4.7 (0.4)	4.7 (0.4)
Family workers, n (SE)[1/]	2.8 (0.2)	2.7 (0.2)	2.9 (0.3)	2.7 (0.2)	2.6 (0.2)	3.1 (0.2)

[1/] does not include family members who are absent for more than 2 months per year

[a] Significant difference between beef buffalo and beef cattle farms with ANOVA ($p \leq 0.05$)

[b] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

[c] Significant difference between herd sizes with ANOVA ($p \leq 0.05$)

4.4.2 Household activities

The average farm size determined in this study was 7.9 ha including 6.6 ha own land and 1.3 ha rented land (Table 4.2). The land holding of the farmers varied strongly, ranging from 0.04 to 181.6 ha for total land, from 0 to 181.6 ha for own land and from 0 to 32 ha for rented land. The farmers allocated on average 3.66 ha (3.1 ha own land and 0.56 ha rent land) to crash crop production and 3.15 ha (2.4 ha own land and 0.75 ha rent land) to animal production including housing, grazing land and fodder cultivation. The rest were used for homestead and non-agricultural activities. According to Tipraqsa et al. (2007) the size of land holdings of farmers in Thailand depends on the farming systems: in the community of Khon Kaen province in the northeastern region, the average size of land holding was 3.9 and 2.7 ha for integrated and commercial farms, respectively. Kehren (1999) reported that while the average size of land holdings was 5.6 ha in Thai farming operations, there were still a number of small farmers who owned less than 1.6 ha, and some were landless, and Satchaphun et al. (2006) mentioned that in the South of Thailand, only 2.3 ha (range 0.16 - 28 ha) of land are managed by small-size buffalo farms. Chatalakhana (2001) mentioned that in northeastern Thailand, village farmers who generally raised 2 to 5 beef buffaloes usually set aside small plots of land of 0.2 to 1 ha for ruminant grazing, which complemented other available grazing areas such as paddy fields.

Table 4.2: Land holding and using of 121 household farms in northeastern Thailand

Land holding and using	Beef buffalo herds			Beef cattle herds		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Land holding, ha (SE)						
Own land [a]	3.1 (3.7)	3.0 (3.9)	21.3 (4.0)	3.7 (3.9)	3.5 (3.9)	6.0 (3.9)
Rented land	0.6 (0.8)	2.2 (0.8)	0.7 (0.8)	0.6 (0.8)	1.9 (0.8)	1.8 (0.8)
Own land using, ha (SE)						
Cropping	2.2 (0.8)	2.2 (0.9)	4.6 (0.9)	3.3 (0.9)	2.8 (0.9)	3.7 (0.9)
Livestock farming	0.4 (3.3)	0.3 (3.4)	13.2 (3.5)	0.2 (3.4)	0.4 (3.4)	0.7 (3.4)
Rented land using, ha (SE)						
Cropping	0.6 (0.2)	0.6 (0.3)	0.4 (0.3)	0.6 (0.3)	0.5 (0.3)	0.6 (0.3)
Livestock farming	0.1 (0.7)	1.6 (0.8)	0.3 (0.8)	0.03 (0.8)	1.4 (0.8)	1.1 (0.8)

[a] Significant difference between herd sizes with ANOVA ($p \leq 0.05$)

Farms with large-size herds managed more land (14.7 ha, including own and rented land) than farms with small- (4.0 ha) and medium-size (5.3 ha) herds ($p<0.05$). Moreover, the large-size herd farms owned more land (13.5 ha) than the small- (3.4 ha) and medium-size (3.2 ha) herd farms ($p<0.05$). This was also reflected by the relationship between number of animals kept and the area of total land holding ($r=0.40$, $p<0.0001$), total land for livestock farming ($r=0.35$, $p<0.0001$), total land owned ($r=0.39$, $p<0.0001$) and own land for livestock farming ($r=0.33$, $p<0.0001$), indicating that the size of land holdings and using depends on the number of livestock, which has a certain need for land (grazing) but is also related to the wealth of farmers. However, there was no significant difference between the buffalo and cattle farms or between different herd sizes concerning the area of own and rented land for cropping and for livestock activities.

On the other hand, the size of total cropping land and own cropland was positively correlated with the number of family members ($r=0.29$, $p=0.001$ and $r=0.26$, $p=0.005$, respectively), but no relationship existed between animal numbers and the area of own cropland. It shows a more secure supply of food for year-around household consumption. Various crops were grown by rural farm households in this area in order to supply household food and income as shown in Table 4.3. The majority (73 %) of households cultivated rice which is the most important staple carbohydrate source for Thai peoples. Some households also grew other cash crops including cassava (29 %), corn (12 %), sugar cane (4 %), vegetables (8 %), woods (2 %) and tree fruits (5 %). Small-scale farm households more frequently planted vegetables for household consumption and income generation (17 %) than medium- (5 %) and large-scale (3 %) farm households ($p<0.05$). Rice is the primary agricultural product in the northeastern region, providing the basis of the traditional subsistence economy. People produce rice mainly for their own consumption but also sell a portion of the harvest in the market (Grünbühel et al., 2003).

Some beef buffalo keepers (26 %) also kept beef cattle on their farms while only very few beef cattle keepers (7 %) integrated beef buffaloes (Table 4.3). Most farms (78 %) kept chickens and around 7 % and 11 % of the households kept pigs and waterfowls, respectively, in order to supply the households with food and income and to preserve their traditional activities. Only one farm integrated goats and allowed them roaming and feeding together with the large animals and sold

them when the household incidentally needed money. Most of the small herd farms (91 %) kept chickens, while this was less frequent in the medium (70 %) and the large (72 %) herd farms ($p<0.05$). Chantalakhana (2001) and Grünbühel et al. (2003) mentioned that livestock were generally utilized for many different purposes by the farmers: small animals such as chickens, ducks and pigs constitute short-term savings and food sources, while buffaloes and cattle supply draught power, long-term savings and income resources.

Table 4.3: Frequency of agricultural activities of 121 farm households in northeastern Thailand

Household activities	Beef buffalo herds			Beef cattle herds		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Crop plantation, % of households						
Rice	73.3	70.0	73.7	70.0	70.0	80.0
Cassava	22.7	30.0	26.3	35.0	25.0	35.0
Corn	13.6	15.0	0	25.0	10.0	5.0
Sugar cane	9.1	0	0	5.0	10.0	0
Vegetables [a]	13.6	5.0	5.3	20.0	5.0	0
Forest	0	5.0	5.3	0	0	0
Tree fruits	0	0	10.5	5.0	10.0	5.0
Livestock keeping, % of households						
Buffaloes	-	-	-	0	0	20.0
Beef cattle	0	35.0	47.4	-	-	-
Pigs	9.1	5.0	10.5	5.0	5.0	5.0
Goats	0	5.0	0	0	0	0
Waterfowls	4.5	10.0	10.5	5.0	20.0	15.0
Chickens [a]	86.4	60.0	68.4	95.0	80.0	75.0

[a] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

Kehren (1999) and Devendra and Thomas (2002a,b,c) agreed that small farm households in Thailand, whose living standard was mostly at the subsistence level, frequently integrated crop and animal husbandry activities, namely cultivation of field crops, horticulture, aquaculture and livestock farming. Livestock including buffaloes, beef cattle, pigs and poultry were most important to these farms, playing a multi-purpose role in both monoculture and multiple cropping systems of small-scale farms where outputs from one sector were used as inputs to other sectors.

4.4.3 Farm labour management

Besides the male household head, family members having a responsibility in livestock activities were the spouses (62 % of households), followed by their children, other relatives, grandchildren and parents as reported in Table 4.4. Household members usually took part in the livestock herding duty (59 % of households), which was the main activity in this livestock production system. However, large herd size farms less frequently (48 % of households) depended on family labour to herd and take care of their animals than the small (57 %) and the medium herd size farms (78 %, $p<0.05$), but large herd size farms usually employed permanently hired workers instead. Labour shortage is the major problem and constraint of livestock keeping nowadays due to out migration of labour to work in the industrial sector or city, which is more attractive for the young generation than agricultural activities. Thereby household labour for tending the livestock was women, children and older persons (Skunmun et al., 2001).

Table 4.4: Farm labour source in 121 beef buffalo and beef cattle farms in northeastern Thailand

Farm labour source	Beef buffalo herds			Beef cattle herds		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Family members, % of households						
Parents (4) [1/]	0	10.0	0	10.0	0	0
Spouse (83)	59.1	60.0	63.2	80.0	80.0	70.0
Children (31)	22.7	15.0	26.3	20.0	35.0	35.0
Grandchild (5)	9.1	0	5.3	10.0	0	0
Other relatives (11)	4.5	15.0	10.5	0	20.0	5.0
Family labour time, % of households						
Year round (30) [a]	4.5	25.0	31.6	15.0	25.0	50.0
Specific season (7)	0	5.0	10.5	5.0	0	15.0
Temporary (73) [a]	68.2	50.0	52.6	70.0	80.0	40.0
Hired labour, % of households						
Permanent labour (12) [a]	0	0	36.8	0	0	25.0
Seasonal labour (3)	0	5.0	5.3	0	0	5.0
Temporary labour (43) [a]	27.3	70.0	21.1	15.0	45.0	35.0

[1/] Number of responses

[a] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

4.4.4 Livestock roles for farm households

The roles of beef buffaloes and beef cattle for farm households in northeastern Thailand are reported in Table 4.5. Most farmers mentioned that they kept their animals to accumulate wealth (savings bank, 95 %), to cover expected expense (buffering function, 86 %), to cover unexpected expense (insurance function, 83 %) and to raise the social status of the farmers (81 %). Nearly half of the households (48 %) kept the animals for earning regular main income and additional income (41 %), and very few farmers kept the animals for preserving traditional activity (conversation aspect, 2 %) and supplying animal power (2 %) and manure (0.8 %); 2 % of the households kept the animals as inherited assets given to their children. The roles of large livestock in northeastern Thailand have changed during the past decades: use of animal power has greatly declined and has been replaced by farm mechanization; at the same time, manure use has declined (Chatalakhana, 2001 and Simaraks et al., 2003). In two villages of Surin province, northeastern Thailand, 92 to 99 % of farmers kept buffaloes as saving sources (Skunmun et al., 2001). For small buffalo farms in southern Thailand, Satchaphun et al. (2006) reported that only 9 % used buffaloes for work; instead, most of the farmers used machines for farm work. In SangSaeng village of northeast region every villager possessed on average 0.65 large animals (buffaloes and cattle). Animal work was a necessity, but at only little more than 4 % remained relatively small as additional workforce (Grünbühel et al., 2003).

In the present study, all beef cattle keepers (100 %) kept their animals for wealth accumulation compared to 91 % of beef buffalo holders ($p<0.05$). This role of animals as a savings bank was also mentioned by medium- and large-scale livestock farms as one livestock farming aim whereas it was less important in small beef buffalo farms ($p<0.05$). Moreover, the large-scale farms usually considered their animals as the main income resource for daily expenses (67 %) and other planned expenses (98 %); in the small-scale (18 % and 76 %, respectively) and medium-scale farms (58 % and 85 %, respectively) these purposes were less important ($p<0.05$). More than half of the farmers (53 %) in southern region of Thailand studied by Satchaphun et al. (2006) kept their buffaloes in order to earn money for the households, and only three among 142 farmers kept their buffaloes for reasons of conservation of animal genetic resources. The results show that farmers kept the livestock mainly for sustaining or improving their livelihoods and to cover the

household needs as well as emergency expenses. Furthermore, the animals were considered to be a sign of household wealth, giving social benefits to their owners.

Dossa et al. (2007) studied reasons for keeping goats in southern Benin. They found that the most important reasons given for keeping the small ruminants related to income earning were ranked high. They are sold mainly when money is needed, for instance in case of emergency (insurance function) or to cover expected expenses (buffering function), and Dossa et al. (2008) stated that gender, ethnicity and perception of risk associated with species are the major factors affecting people's choice of species. These finding highlight the financing and insurance roles that goats and sheep, particularly goats, are playing in the south of Benin. On the contrary, Simaraks et al. (2003) found that in northeastern Thailand, livestock roles as a savings bank and in bartering systems had been mostly replaced by a buy-and-sale system in 2002, and its other roles related to passing on of inheritance, rituals etc. had declined and been replaced mainly by consumer goods.

Table 4.5: Roles of livestock in 121 beef buffalo and beef cattle farms in northeastern Thailand

Livestock roles, % of households	Beef buffalo herds			Beef cattle herds		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Main income (59) [1/ a]	31.8	65.0	57.9	5.0	50.0	75.0
Supplementary income (50)	31.8	45.0	36.8	65.0	45.0	25.0
Unexpected expense (101)	95.5	85.0	63.2	90.0	80.0	85.0
Expected expense (104) [a]	81.8	80.0	100.0	70.0	90.0	95.0
Saving (115) [a, b]	77.3	95.0	100.0	100.0	100.0	100.0
Social status (98)	77.3	80.0	94.7	65.0	90.0	80.0
Draught power (2)	9.1	0	0	0	0	0
Manure (1)	0	0	0	5.0	0	0
Inheritance (3)	9.1	0	0	5.0	0	0
Traditional activity (3)	4.5	5.0	0	5.0	0	0

[1/] Number of responses

[a] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

[b] Significant difference between beef buffalo and beef cattle farms with Fisher's Exact test ($p \leq 0.05$)

Most of emergency cases farm households had to handle in the 5 years prior to our study were covered by unplanned sales of livestock (59 % of responses) and other agricultural products (18 % of responses) coming from other livestock species and cash crops (Figure 4.1). Besides unplanned sales of livestock and other farm products, some farmers needed to loan money to cover unplanned household consumption and emergency debts. For unplanned ceremonies such as funerals, farmers partially spent their savings money (28 % of responses) and off-farm income (9 % of responses). Moreover, saving money was partly able to cover unplanned agricultural inputs needed, health and education expenses. Loaned money was an alternative source of emergency money for some farmers to cover unplanned household consumption, emergency debts, health and agricultural input costs. Besides the money from farm product sales, farmers needed off-farm money sources (15 % of responses) for instance off-farm wage and children's money to bring their households over a drought or flood period.

Chantalakhana (2001) stated that in case of crop failures due to drought or flood, buffaloes or cattle would be sold in order to obtain sufficient cash income to purchase enough rice for year-round family consumption. In the case of traditional ceremonies such as marriage or some religious rites, rural farmers sold buffaloes or cattle for cash or slaughter for meat.

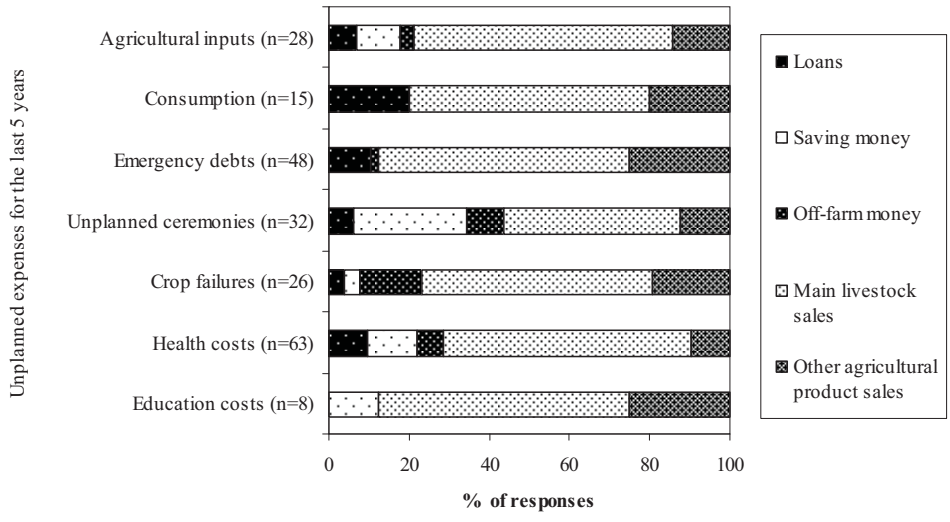

Figure 4.1: Sources of money for unplanned expenses during the last 5 years of 121 beef buffalo and beef cattle farms in northeastern Thailand (Numbers in parenthesis = responses)

Sources of money for planned expenses effectuated during the past 5 years, shown in Figure 4.2, resemble those of the unplanned expenses (Figure 4.1). Most of planned expenses were covered by livestock product sales (57 % of responses) and other agricultural product sales (21 % of responses). Costs for replacement stock were almost always covered by selling the livestock (78 % of responses). Savings money (12 % of responses) and off-farm money (8 % of responses) were also important sources for all planned household expenses. Some farmers needed to lend money for house and livestock barn construction and maintenance to complete the expenses.

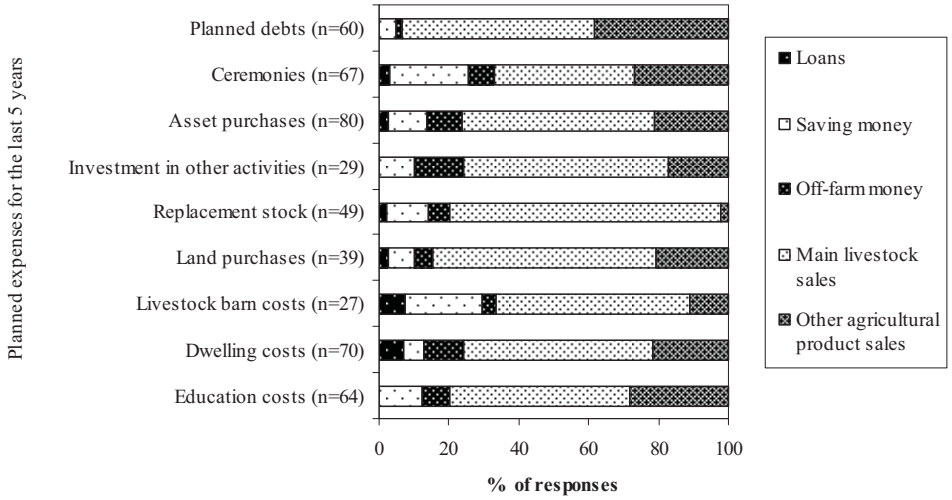

Figure 4.2: Sources of money for planned expenses during the last 5 years of 121 beef buffalo and beef cattle farms in northeastern Thailand (Numbers in parenthesis = responses)

Livestock manure produced on the 121 livestock farms studied was mainly used for cash crop fertilizing (34 % of responses), following by use as a gift (32 % of responses) and sale (27 % of responses) (not shown in the table). Only few farmers applied manure to pasture land (5 % of responses) or used it for other purposes (3 % of responses) such as biogas generation, crop residue exchange, disposal, etc. Among the beef cattle farmers 68 % sold livestock manure for earning additional income, as compared to 50 % of beef buffalo keepers ($p<0.05$). Moreover, more larger herd size farms (72 % of households) than small (41 %) and medium herd size farms (65 %) sold livestock manure ($p<0.05$). According to Grünbühel et al. (2003), buffaloes and beef cattle in northeastern Thailand were left to graze freely on the harvested fields during the dry season, where they also leave their droppings. At night and during much of the vegetation period,

the animals were kept in stables where they were fed with straw and grass. Here, the faeces mixed with straw bedding and were brought to the field once every year before the planting season. Although farmers were generally aware of the value of manure, it was often wasted. During the months with heavy rainfall, manure was diluted in non-roofed corrals, or else ran off the pasture.

Livestock provide year-round flow of essential products and sustain the employment and income of farm households. Animals are used as cash generating assets and an easily accessible liquid asset, or "living stock" and hence are crucial for the purchase of consumer goods and procurement of farm inputs. In Colombia, the most important reason for selling their cattle of smallholders was due to financial crisis and needed cash such as payment for health bills of family members, off debts and/or use the cash to survive due to crop failure (Rivas et al., 2005). In the Eastern Amazon, the socio-cultural acceptance and valuation of cattle production is high. Owning cattle increases the self-consciousness and status of the smallholders and brings them closer to the big ranchers (Siegmund-Schultze et al., 2007). In addition in rural areas of developing countries, livestock are also an important source of food and cash, and contribute draught power and manure for crop production. They also supply such non-food items as hides, skins, wool, transportation and fuel (from dung), convert crop residues and fibrous materials of no value into protein of high quality, serve as a store of wealth and as a means of using vast areas of natural grasslands in regions where crop production is impractical (Rege and Bester, 1998). Besides the ability to change cattle into money at any time, no market fees were levied, because the smallholders did not sell their animals at official market places. Furthermore, cattle were considered nearly self-sufficient by growing and reproducing on their own, thus demanding very little input from the farmers (Siegmund-Schultze et al., 2007).

Studying the cash generating function of cattle in the Eastern Amazon, Siegmund-Schultze et al. (2007) found that nearly two-thirds of the offtake from cattle smallholder farms was used for investments in crops, cattle exchange, pasture fencing or in the household, and around one-third was used for maintenance of the various farm activities. Gifts and medical emergencies accounted for <0.5 % each. Some animal sales were due to pasture shortage, the need to replace the breeding bull or to remove a savage animal, but these were secondary considerations.

Financing, i.e. enabling and facilitating purchases and investments was considered the main intangible benefit of living stock for a smallholder farms.

Ouma et al. (2003) estimated the value of non-market, socio-economic benefits of intensive, semi-intensive and extensive cattle farming systems in Kenya though contingent valuation method. The results indicate that these benefits are highly valued by cattle keepers and comprise approximately 20 % of the animal's total value across the three systems. They are influenced by various production systems and household related factors.

4.4.5 Farm household livelihoods

All studied farm households had access to electricity (not shown in the table). Most of them (95 %) were directly connected to the local electricity authority but some of them (4 %) shared from their relatives and one farmer generated the electricity with a solar cell electric generator supported by the government. Main kitchen fuels for the farm households were collected wood, charcoal and liquefied petroleum gas. The households usually combined local fuels with the propane gas (88 % of households) depending on the availability and access of local fuel materials. Almost all households (85 %) used publicly available pipe water, while the rest depended on other water resources such as wells, underground water and ponds. Rainwater was the main source of drinking water for households (98 %) and only two households drank public pipe water and one household drank from both sources. Grünbühel et al. (2003) reported that in SangSaeng village, northeastern Thailand, household water use has probably slightly increased since the installation of a public ground water pumping and storing facility in 1994. Previously, all household water was manually carried from the well and stored in large jars. In the rainy season rainwater was used for all household purposes, which is still the case today. Moreover, charcoal-oven cooking was still ubiquitous and propane gas was used as additional heat source only in 12 households.

The dwelling structures and styles of 121 farm households are shown in Figure 4.3. Farmers keeping a large number of animals lived in modern houses which were made from solid materials compared to farmers who kept fewer animals ($p<0.05$). On the other hand, traditional houses which were made from simple materials were mainly owned by the small herd size farms ($p<0.05$). Moreover, most of households (74 %) lived in good condition houses, followed by repair needing houses (22 %) and poor condition houses (4 %). However, the conditions of houses were not significantly different between cattle and buffalo farms and between different herd size farms.

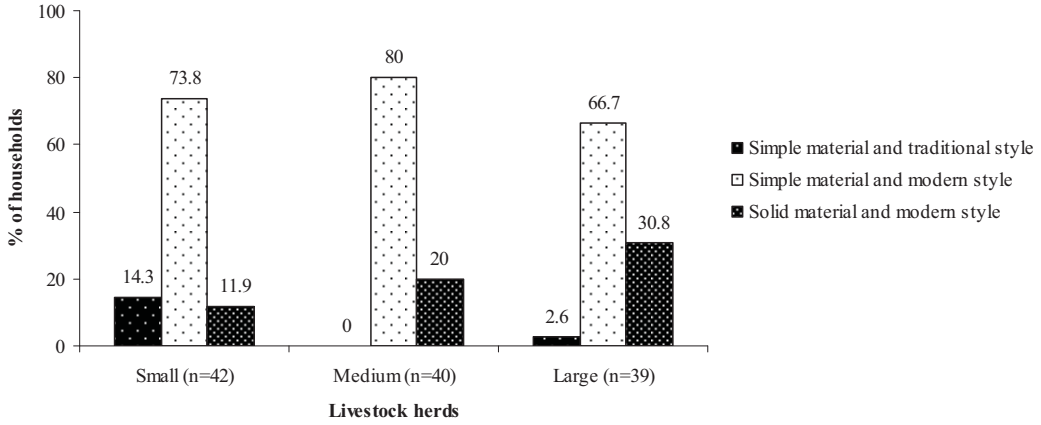

Figure 4.3: Dwelling structures and styles of small, medium and large size herd farm households in northeastern Thailand

Some household assets owned by livestock farms are shown in Table 4.6. There was no significant difference between beef buffalo and beef cattle farms in the number of household assets. However, households keeping a large number of animals had higher numbers of household assets such as computers, washing machines, refrigerators, motorbikes, trucks and cars than households keeping fewer animals ($p<0.05$). This is certainly related to the economic benefit that farmers achieved from their livestock farm enterprises. Moreover, more farmers who owned a large number of animals had access to commercial health insurances than farmers who owned a small number of animals ($p<0.05$).

The number of tractors and two-wheeled tractors was not significantly different between beef buffalo and beef cattle farms and between differently large holdings. As mentioned above, farmers in this area shifted farm power use from draught animals to mechanization. Skunmun et al. (2001) found that the number of two-wheeled tractors dramatically increased in two villages of northeastern Thailand during 1998 to 2000, while the number of household raising buffaloes and cattle greatly declined in the same period. In 2000, most of households (92 %) used only two-wheeled tractors for farm power while some farmers used both two-wheeled tractors and buffaloes, and very few used only buffaloes.

Table 4.6: Average number of some household assets and the access to commercial health insurance of 121 farm households in northeastern Thailand

Category	Livestock herd sizes		
	Small (n=42)	Medium (n=40)	Large (n=39)
Household assets, number (SE) [1/]			
Televisions	1.26 (0.08)	1.20 (0.06)	1.41 (0.13)
Computers	0.02 (0.02)^{b}	0.13 (0.05)^{b}	0.33 (0.09)^{a}
Washing machines	0.26 (0.07)^{b}	0.45 (0.08)^{ab}	0.59 (0.09)^{a}
Refrigerators	0.74 (0.08)^{b}	0.93 (0.07)^{b}	1.23 (0.08)^{a}
Tractors	0.02 (0.02)	0.05 (0.03)	0.15 (0.06)
Two-wheeled tractors	0.62 (0.08)	0.48 (0.08)	0.79 (0.13)
Motorbikes	0.95 (0.11)^{b}	1.15 (0.10)^{b}	1.61 (0.16)^{a}
Cars	0.05 (0.03)^{b}	0.15 (0.06)^{b}	0.54 (0.12)^{a}
Trucks	0.00 (0)^{b}	0.03 (0.03)^{b}	0.13 (0.05)^{a}
Agricultural trucks	0.24 (0.07)	0.28 (0.07)	0.36 (0.09)
Commercial health insurance access, % [c]	28.6	47.5	56.4

[1/] Different letter superscripts are significant different with ANOVA ($p \leq 0.05$)

[c] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

4.5 Conclusions

Beef buffaloes and beef cattle are an important component in integrated farming systems of small household farms in Thailand's northeast region. Complementary use of farm resources is properly practiced in this system in order to meet the multipurpose goals of rural households and maximize the efficient use of those resources. However, the roles of buffaloes and cattle have greatly changed from traditional or ritual plays towards beef farming enterprises pursuing income with increasing modernization. Household income earning is the most important reason for keeping both animals, contributing to household expenses covering, savings, buffering and insurance functions. Most of planned and unplanned expenses in farm households are covered by the livestock farming. Improving farmers' social status is agreed by rural farmers due to getting higher priority to get loan and improving wealth status. The livestock farming allows the farmers to improve their household wealth and livelihoods, and have a better health and life expectation according to the number of animals kept on farms. When market-oriented livestock production systems are to be developed, not only the non-market (socio-economic) but also market benefits of the livestock should be considered and paid more attention by the researchers, government and stakeholders in order to improve and develop the sustainable systems.

CHAPTER 5

Feed resources and feeding management on beef buffalo and beef cattle farms in northeastern Thailand

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Feed resources and feeding management on beef buffalo and beef cattle farms in northeastern Thailand

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5.1 Abstract

Feed shortage is the major constraint of livestock farming in Thailand due to expansion of cropping land reflecting the increased human population. In order to improve feed availability on livestock farms, the year-round feed supply and feeding management need to be investigated. Therefore, a semi-structured questionnaire was used to collect such information on a total of 121 beef buffalo and beef cattle farms in the Nakhon Ratchasima province, northeastern Thailand through a single-visit, multiple-subject survey between October 2007 and May 2008. Herding was practiced by 94 % of farms while tethering was used only by small-scale farms. The animals were kept on small cultivated pasture areas (3.1 ha) with a very low pasture allowance (0.1 ha TLU^{-1}). Thus, their feed mainly consisted of external farm resources: vegetation of communal grasslands and forests during the rainy season and of harvested crop fields, shared by the community, during the dry season. Because of the limited availability and quality of on-farm and natural forages, the animals were fed green forages on average 8 months per year (range 2 - 12). Farmers rarely practiced feed supplementation due to the high cost and the low availability of concentrate feeds, even though breeding animals were given the highest priority for supplementation. An extensive feeding system was mainly found on resource-poor farms where buffalo raising predominates. The risk of feed deficiency was increasing with the number of animals kept. To ensure year-round feed supply and to promote the sustainability of livestock farming, the productivity of the natural vegetation should be improved and effective on-farm feed production and crop residue utilisation programmes should be developed.

Keywords: Area allowance; Communal feed resources; Feed supplementation; Pasture cultivation; Resource-poor farms; Thailand

5.2 Introduction

Most buffalo and cattle farms in Thailand are owned by small-scale, resource-poor farmers who rely on a few improved animal and crop varieties, high levels of external inputs and are characterized by an inefficient use of those farm resources (Tipraqsa, 2007). The animals are traditionally kept in small herds and on small pastures with simple housing in backyards. Their feed depends mainly on the availability of native grasslands and crop residues (Na-Chiangmai, 2002). With regard to the increase of the human population, the demand for cropping areas increased. Therefore, grazing areas became a limited resource and a major constraint for livestock production in Thailand (Khemsawat et al., 2003). At the same time, livestock farming under improper management is prone to interfering social livelihoods and being harmful to the local environment because of high competitive use of the community resources (Chantalakhana, 2001; Devendra, 2002b).

The cultivation of improved pastures has been increasingly used by Thai farmers. However pastures and fodders are still insufficient for the animals, especially during the dry season (Khemsawat et al., 2003). Thai farmers seek numerous alternatives to keep their animals surviving throughout the year by using crop residues, preserved straw and other forms of non-conventional feeds (Devendra, 2000; Khemsawat et al., 2003). However, low productivity and body weight losses of the livestock are still caused by deficiency of forages particularly during the dry season (Devendra and Thomas, 2002b). The feeding management of livestock and the use of common feed resources are crucial factors in their future development (Kehren, 1999). To increase livestock farm productivity, year-round feeding management has to be intensively concerned to ensure adequate feed supply for animals (Devendra and Thomas, 2002b; Khemsawat et al., 2003). The objective of this research was to assess the feed supply throughout the year and the feeding management and strategies of beef buffalo and beef cattle farms in northeastern Thailand in order to give recommendations to overcome the problems of inadequate feed supply.

5.3 Materials and Methods

See Chapter 3

5.4 Results

5.4.1 Feeding systems, pasture lands and area allowance

Most livestock farms (94 %) practiced herding followed by tethering (19 %), while free grazing, stall feeding (zero grazing) and paddocking were used only by some farms (Table 5.1). Tethering was only used by small-scale farms. Cattle farms practiced paddock grazing more frequently than buffalo farms (13 % of cattle vs. 2 % of buffalo farms, $p<0.05$). Only two cattle farms sometimes kept and fed their animals in the barn.

Table 5.1: Feeding systems, pasture area and area allowance of 121 beef buffalo and beef cattle farms in northeastern Thailand

Feeding practices	Beef buffalo farms			Beef cattle farms		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Feeding systems, % of farms						
Free grazing (9) [1/]	9.1	10.0	10.5	0	5.0	10.0
Zero grazing (2)	0	0	0	5.0	5.0	0
Tethering (23) [a]	68.2	0	0	40.0	0	0
Herding (114)	100.0	100.0	89.5	85.0	95.0	95.0
Paddocking (9) [b]	0	0	5.3	5.0	20.0	15.0
Pasture lands, ha (SE)	0.45 (3.3)	1.86 (3.5)	13.4 (3.6)	0.25 (3.5)	1.84 (3.5)	1.83 (3.5)
Area allowance, ha TLU^{-1} (SE)						
Agricultural lands [c]	0.80 (0.12)	0.23 (0.13)	0.36 (0.13)	1.09 (0.13)	0.37 (0.13)	0.16 (0.13)
Pasture lands	0.10 (0.06)	0.06 (0.06)	0.24 (0.06)	0.06 (0.06)	0.13 (0.06)	0.04 (0.06)

[1/] Number of responses

TLU = Tropical Livestock Units: 1 for bulls; 0.7 for cows; 0.5 for heifers and young bulls; 0.2 for calves

[a] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

[b] Significant difference between beef buffaloes and beef cattle with Fisher's Exact test ($p \leq 0.05$)

[c] Significant difference between herd sizes with ANOVA ($p \leq 0.05$)

The pasture size was on average 3.1 ha per farm (range 0 - 164.6, SD 15.9). The size of the pasture was not significantly different between buffalo and cattle farms and between herd sizes. Across animal species and herd sizes, the area allowance was 0.51 ha per TLU (SD 0.66) on agricultural lands and 0.10 ha per TLU (SD 0.27) on own pastures. The small-scale farms (0.95 ha per TLU) had a higher allowance of agricultural lands than medium-scale (0.30 ha per TLU) and large-scale farms (0.26 ha per TLU, $p<0.05$). The allowance of cultivated pasture was not significantly different between animal species and between herd sizes.

5.4.2 Main sources of forages throughout the year and their limitations

Sources of year-round forages supply for livestock are shown in Table 5.2. Communal resources (forests and native grasslands) and uncultivated lands were ranked high during the rainy season while in the dry (cool and hot) season, harvested crop fields shared by the community, and in particular rice paddy, became the most important feed sources. However, in this period other community feed resources were still important as a supplementary feed source, while own cultivated pastures were of minor importance throughout the year. Green forages such as grasses, legumes and tree leaves which were cut and carried from natural or private lands were available only during the rainy season while crop residues including rice straw and corn husks were alternative feed sources supplied throughout the year.

The vast area of community forest was the main feed source for farms keeping a large number of animals (56 % of large- vs. 40 % of medium- vs. 26 % of small-scale farms, $p<0.05$), while small-scale farms relied mainly on small areas of private or public lands consisting of marginal or boundary areas and roadside verges as well as on cut and carried forages when compared to larger-size farms ($p<0.05$). Cattle farms (38 %) supplied crop residues for their animals more frequently than buffalo farms (20 %, $p<0.05$).

Table 5.2: Ranking of main forage resources across the whole year as mentioned by 121 beef buffalo and beef cattle farms in northeastern Thailand

Main forage sources	Mean rank (Rank)[1/]		
	Rainy season	Cool season	Hot season
Cultivated pastures	1.82 (4)	2.43 (6)	2.00 (4)
Communal pastures	1.73 (3)	1.80 (2)	1.80 (3)
Community forests	1.24 (1)	1.80 (2)	1.50 (2)
Marginal areas	2.24 (6)	2.65 (7)	2.50 (8)
Roadsides	2.14 (5)	2.73 (8)	2.44 (7)
Uncultivated lands	1.52 (2)	2.32 (5)	2.10 (6)
Cut and carried forages	3.36 (8)	-	-
Crop residues [2/]	3.09 (7)	2.93 (9)	2.51 (9)
Harvested rice fields	-	1.15 (1)	1.20 (1)
Other harvested crop fields [3/]	-	2.03 (4)	2.00 (4)
Kendall' s coefficient (W) [4/]	0.25***	0.36***	0.29***

[1/] The lower the rank, the more important the source

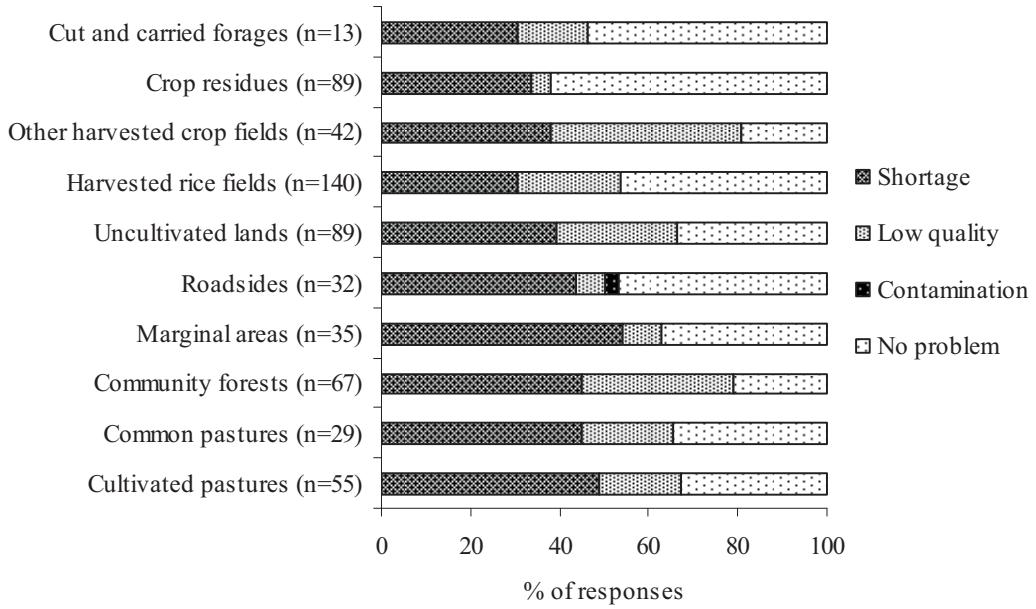
[2/] Rice straw and corn husks

[3/] Corn, cassava, sugarcane and mungbean

[4/] W ranges from 0 (no agreement) to 1 (complete agreement) and the higher its value the higher is the level of agreement between groups

*** $p \leq 0.001$

According to the farmers, the major limitation for using forage resources was their low availability (Figure 5.1). With respect to the exploitation of small areas of marginal lands and roadsides, forage lacking was stated as the main limitation while for large areas of communal resources including forests and natural grasslands as well as uncultivated lands both limited quantity and quality were mentioned. Low availability was stated as a main problem when supplying crop residues, although the majority of the farmers did not mention any problem with respect to crop residue use. For harvested crop fields, a low availability of feeds and low nutrient contents were mentioned, particularly of crop wastes from upland crop fields such as corn, cassava, sugarcane and mungbean. Inadequate feed supply was a main limitation in the exploitation of cultivated pastures.



Crop residues = rice straw and corn husks; other harvested crop fields = corn, cassava, sugarcane and mungbean

Figure 5.1: Limitations of main forage resources given by beef buffalo and beef cattle farms in northeastern Thailand (Numbers in parentheses = number of responses)

5.4.3 Pasture cultivation and green forage supply

Less than half (44 %) of the livestock farms cultivated pastures (Table 5.3). Cattle farms (62 %) cultivated pastures more frequently than buffalo farms (26 %, $p<0.05$). Improved grass varieties were adopted by cattle farmers for pasture cultivation while on buffalo farms native grasses dominated. Legumes were not cultivated on any farm. Cattle farmers invested in grass seeds or stem stocks for cultivating the pastures (84 % of pasture-cultivating cattle farms vs. 44 % of pasture-cultivating buffalo farms, $p<0.05$), while 56 % and 14 % of pasture-cultivating buffalo and cattle farmers, respectively, did not invest in the improvement of pastures. Grazing dominated in the utilization of the cultivated pastures on pasture-cultivating buffalo farms (94 % vs. 38 % of pasture-cultivating cattle farms, $p<0.05$) while cattle farms practiced both cut-and-carry and grazing systems.

The farmers were able to offer green forage to their animals during an average of 8.04 months (range 2 - 12, SD 2.94), with not significant differences between farm types and between herd sizes. The major limitation for this practice was the lack of land (45 % of responses) and water supply (35 % of responses) while some farmers mentioned lack of knowledge and capital, and seasonal limitations. Buffalo farmers mentioned the lack of land as the main limitation of green forage provision more frequently than cattle farmers ($p<0.05$).

Table 5.3: Pasture management and green forage supply on 121 beef buffalo and beef cattle farms in northeastern Thailand

Parameters	Beef buffalo farms			Beef cattle farms		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Pasture provision (53)[1/], % of farms [a]	27.3	20.0	31.6	60.0	75.0	50.0
Forage species, % of responses						
Native grasses (14)	66.7	75.0	33.3	8.3	20.0	10.0
Exotic improved grasses (32) [a]	33.3	25.0	16.7	83.3	73.3	70.0
Both (7)	0	0	50.0	8.3	6.7	20.0
Inputs for pasture, % of responses						
Livestock manure (24)	12.5	20.0	22.2	20.5	24.0	26.8
Chemical fertilizers (13)	12.5	0	11.1	16.7	16.0	14.3
Irrigation (6)	0	0	0	12.5	4.0	9.5
Forage seeds or stem stocks (38) [a]	25.0	20.0	44.4	45.8	44.0	42.9
No input (14) [a]	50.0	60.0	22.2	4.2	12.0	4.8
Use of pastures, % of responses						
Cut and carry (13)	0	25.0	0	16.7	40.0	40.0
Grazing (29) [a]	100.0	75.0	100.0	41.7	33.3	40.0
Both (11) [a]	0	0	0	41.7	26.7	20.0
Green forage provision, months (SE)	8.45 (0.69)	7.65 (0.72)	8.24 (0.61)	7.85 (0.80)	7.20 (0.58)	8.80 (0.49)
Limitations of green forage supply, % of farms						
Lack of knowledge and capital (15)	13.6	5.0	10.5	15.0	15.0	15.0
Lack of water (45)	27.3	40.0	36.8	40.0	60.0	20.0
Seasonal limitation (11)	9.1	5.0	15.8	5.0	5.0	15.0
Lack of land (59) [a]	45.5	55.0	68.4	35.0	40.0	50.0

[1/] Number of responses

[a] Significant difference between beef buffaloes and beef cattle with Fisher's Exact test ($p\leq0.05$)

5.4.4 Feed supplementation and limitations of the practice

Only half of the farmers (49 %) supplemented concentrate feeds to their animals (Table 5.4). Salt (28 % of farms) and mineral blocks (22 % of farms) were the main supplements, whereas very few farmers provided mixed feed, rice bran, cassava chips, molasses and corn meal. Large-size farms supplemented salt more frequently than smaller farms ($p<0.05$) while cattle farmers supplied various supplements including mixed feed, rice bran and mineral blocks more frequently than buffalo farms ($p<0.05$). Rice straw was mainly used as forage supplementation (79 % of farms), followed by cut and carried forages (63 %) while only some farmers supplemented other roughages such as corn husks, hay and silage. Cattle farms supplemented more roughages including rice straw, green forages and corn husks compared to buffalo farms ($p<0.05$).

Table 5.4: Feed supplementation on 121 beef buffalo and beef cattle farms in northeastern Thailand

Feed supplementation, % of farms	Beef buffalo farms			Beef cattle farms		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Concentrate feeds						
Mixed feed (14) [1/, a]	0	0	0	10.0	30.0	30.0
Cassava chips (8)	9.1	0	0	10.0	10.0	10.0
Rice bran (12) [a]	0	0	0	15.0	35.0	10.0
Corn meal (1)	0	0	0	0	5.0	0
Salt (34) [b]	4.5	10.0	52.6	15.0	40.0	50.0
Mineral blocks (26) [a]	0	15.0	10.5	35.0	40.0	30.0
Molasses (2)	0	5.0	0	0	5.0	0
No offer (62) [a, b]	86.4	75.0	47.4	55.0	20.0	20.0
Roughage feeds						
Rice straw (96) [a]	90.9	45.0	68.4	85.0	95.0	90.0
Green forages (76) [a]	54.5	25.0	57.9	80.0	80.0	80.0
Corn husks (14) [a]	0	0	5.3	20.0	15.0	30.0
Hay and silage (5)	4.5	0	0	5.0	10.0	5.0
No offer (15)	4.5	35.0	15.8	5.0	5.0	10.0

[1/] Number of responses

[a] Significant difference between beef buffaloes and beef cattle with Fisher's Exact test ($p\leq0.05$)

[b] Significant difference between herd sizes with χ^2 test ($p\leq0.05$)

In contrast to no priority of animals with respect to concentrate feed supplementation on buffalo farms, cattle farmers supplemented breeding bulls first, followed by animals with a poor body condition. For 57 % of the farmers who prioritized animals for forage supplementation, calving cows (53 % of responses) were the most important, followed by breeding bulls, sick animals and animals of poor condition. Additionally, for cattle farms supplementing roughages mating bulls were more important than for buffalo farms (17 % of responses on cattle vs. 3 % on buffalo farms, $p<0.05$). Calving cows (41 % of responses on large- vs. 31 % on medium- vs. 14 % on small-scale farms, $p<0.05$) and sick animals (20 % of responses on large- vs. 12 % on medium- vs. 0 % on small-scale farms, $p<0.05$) were given the highest priority for roughage supplementation by the large-scale farms compared to smaller farms.

Problems or limitations of supplying supplementary feeds are shown in Figure 5.2. The high price (64 % of responses) was the most important limitation of concentrate feeding whereas poor access due to high competition (44 % of responses), high price (28 % of responses) and shortage (27 % of responses) were stated as important limitations of forage supplementation. The low quality of supplementary feeds was only mentioned by 1.5 % of all farmers.

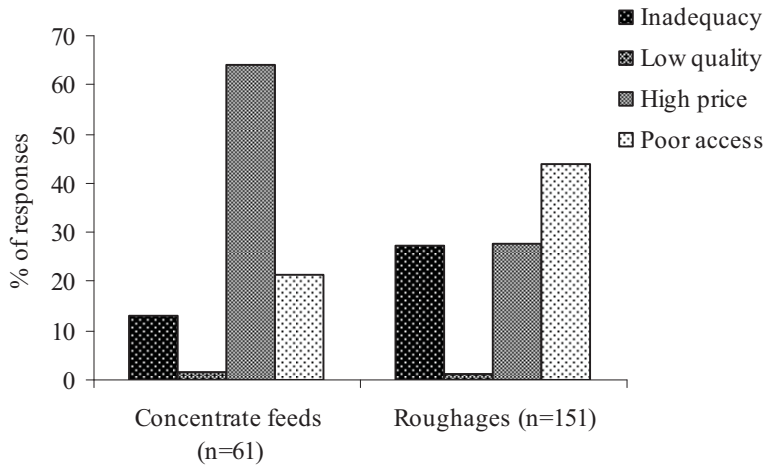


Figure 5.2: Limitations of feed supplementation mentioned by 121 beef buffalo and beef cattle farmers in northeastern Thailand (Numbers in parentheses = number of responses)

5.5 Discussion

Herding was broadly practiced by beef buffalo and beef cattle farms in the study area. Based on the use of off-farm feed resources, this strategy enables the resource-poor farmers to meet their animals' requirements. It reflects the small pasture area holdings and very limited on-farm feed allowance for the animals found in this study. While with a tethering system feed allocation of small-scale farms was satisfied by on-farm resources or by small areas nearby the farms, large-scale farms relied mainly on the large areas of communal resources because of their higher number of animals. This indicates that resource-poor livestock farming relying on communal property resources is prevalent in this area. The more animals the farmers keep on farms the more external feed resources they rely on. This relationship is shown in other studies as well. In the southern part of Thailand (Satchaphun et al., 2006), most buffalo farmers (61 %) practiced a herding system due to a high availability of natural grasslands and at the same time owned only small pasture areas (an average 0.2 ha TLU^{-1}), while 28 % of the farmers used either herding or tethering and only 11 % relied only on the tethering system. In Nakhon Si Thammarat province, southern Thailand, Punsawat et al. (2008) reported that 56 % of the buffalo farmers used herding while tethering was practiced by 35 % of the farms. On average only 1 ha of pasture was used for buffalo raising with a limited pasture allowance (0.18 ha TLU^{-1}) (Punsawat et al., 2008). The study of Simaraks et al. (2003) was conducted in four villages in the northeastern region of Thailand. In villages of Mukdahan and Si Sa Ket provinces, fewer numbers of cattle and buffaloes were kept and the cut and carry system was mainly practiced to feed the tethered animals because the paddy land was used for dry season crops. On the other hand, in the villages of Khon Kaen and Kalasin provinces, a traditional grazing system was practiced due to a higher availability of public and uncultivated land (Simaraks et al., 2003). The findings indicate that livestock rearing systems vary among areas, depending on the availability of forages from private and/or public property resources and on the number of animals kept on farms.

The year-round feed supply for the livestock in the studied area relies on various resources which can be categorized into public and private. Share of communal forages and crop fields after harvesting was very important for feed allocation which enabled the farmers to provide feed for their animals throughout the year, while forages produced on-farm accounted for a small part of

the total feed supply. Crop residues, particularly rice straw, were used in case of a lack of communal resources or as supplementary forage throughout the year. This underlines the importance of communal feed resources in feed supply throughout the year for the studied low-input farming system. The findings indicate that land use patterns, accessibility to resources and seasonal variations affect the feed availability of the rural livestock farms in this area. The feed supply patterns for the livestock in this area are in agreement with other authors (Kehren, 1999; Skunmun, 2001; Chantalakhana and Skunmun, 2002). However low quantity and quality of forages was a serious problem of the livestock farms in this area who rely mainly on natural feed resources and crop residues. The constraints are probably caused by a high competitive use, a high fibre content of native grasses and crop residues as well as a limited feed resource due to seasonal variations and cropping patterns. Furthermore, availability of crop residues such as rice straw as the main conserved feed was limited because of a high demand and competitive use. The low production of cultivated pastures was due to the small sizes of pastures, the lack of cultivation inputs and the restricted use of improved forage species that only included grasses and no legumes. The results show that the livestock farmers in this area pay little attention to on-farm feed production and also to the quality of forages. Due to the fluctuation of quantity and quality of natural feed resources, the farmers were not able to supply green forages for their animals throughout the whole year. Our results are in agreement with those of Satchaphun et al. (2006) from southern Thailand, where buffalo farmers (7 %) rarely cultivated pastures due to a high availability of common resources and small herd sizes. In Nakhon Si Thammarat province, southern Thailand (Punsawat et al., 2008), only 3 % of buffalo farmers cultivated pastures. Main constraints of buffalo farming stated in this study were the lack of land, decreasing natural grasslands and the lack of forages during flood and drought periods (Punsawat et al., 2008). In smallholder cattle farms in Ang Thong province, central Thailand (Tumwasorn et al., 1995), only half of the farmers had pastures with an average size of 0.3 ha and thus natural vegetation was the main forage resource. Only 23 % of the farmers in this area were able to offer a sufficient amount of feed to their animals, and rice straw was the major feed during the dry season (Tumwasorn et al., 1995). Seventy-two percent of small cattle farms in Uthai Thani province, central Thailand, cultivated pastures on 0.96 to 2.4 ha per farm (Tumwasorn et al., 1996a). For the Mid-hills of the Western Development Region of Nepal, Paudel (2009) reported that only 6 % of the farmers had

green forage available throughout the year for their buffaloes while poor quality rice and wheat straw were the major feed sources.

Only half of the farmers in the study area fed concentrate feeds while forage supplementation was routinely practiced. This indicates that the farmers pay more attention to adequate supply of roughages as the main source of nutrients for the ruminants than to concentrate feed supplementation. However, salt and mineral blocks were often provided by some farmers in order to compensate the low level of essential minerals in native forages and crop residues. However, not all animals received supplements due to the high price of concentrate feeds and low availability of supplementing roughages. The highest priority for supplementation was given to breeding animals and those with poor body condition. The quality of the supplements was of minor importance to the farmers, because their accessibility and availability were limited. In Nakhon Si Thammarat province, southern Thailand, Punsawat et al. (2008) found that 94 % of the farmers never provided concentrate feeds for buffaloes and only 27 % sometimes supplied mineral blocks. Due to the small number of animals and the high availability of forage resources, 92 % of the farmers did not store any roughage even though the majority of stored forage was rice straw (Punsawat et al., 2008). In smallholder cattle farms in the central region of Thailand (Tumwasorn et al., 1995 and 1996a), 67 - 70 % of the farmers never provided concentrate feeds for the animals. Mineral supplementation was used by 48 - 63 % of the farmers while only a few farmers supplemented urea and molasses. In regions with low access to communal resources, crop residues, particularly rice straw, is often fed during the crop-growing season when animals have little or no access to grazing, and during the dry season when other feed sources are scarce (Devendra and Thomas, 2002c).

Rice straw was the most important roughage supplement for the animals in the studied area. Because of a huge supply of rice straw from rice production, farmers fed rice straw *ad libitum* to beef cattle and buffaloes during the dry season and during the rainy season when rice fields are inaccessible to the animals (Khemsawat, 2003). In Asia, rice straw is the principal fibrous residue fed to over 90 % of the ruminants (Devendra and Thomas, 2002c). Although the low nutrient content and digestibility of rice straw is widely known (Khemsawat, 2003), most of the farmers in this area stated the lack of available rice straw due to highly competitive use as an important

limitation, while only few farmers mentioned its low quality. No treatments were used to upgrade rice straw quality, which was also reported by Paudel (2009) from Nepal. Other crop residues such as maize stover and corn husks, cassava and sugarcane leaves and mungbean provided substantial sources of roughages in the studied area. This is consistent with other reports from different regions of Asia (Chantalakhana, 2001; Devendra and Thomas, 2002b,c; Kawashima, 2003; Khemsawat, 2003). On a commercial feedlot farm, namely Lung Chao Farm, located in Suphan Buri province, central Thailand (Phonbumrung and Khemsawas, 1999), various types of crop wastes were used such as cassava chips, rice bran and husks, corn by-products, millet stovers, coconut meal, oil palm by-products, rubber seed meal, brewery grain, pineapple waste, baby-corn waste, and sugarcane waste. Devendra and Thomas (2002b,c) mentioned that the type and quality of the residues varies according to the agro-ecological zones and the cropping patterns. Crop residues and by-products are fed to ruminants throughout the year or seasonally, depending on the availability of grazing lands and the supplements.

Results of this study indicate that feeding management on cattle farms is more intensive than on buffalo farms. While buffalo farms relied mainly on native grasses from natural resources, pastures with improved grasses were cultivated and supplement roughages and concentrate feeds were fed on cattle farms. It is widely known that buffaloes digest poor-quality and high cellulose roughages more efficiently than cattle and have a wider range of grazing preferences including aquatic plants. In developing countries small-scale farmers commonly use crop residues and by-products to feed their animals, particularly buffaloes (Indramangala, 2001; Chantalakhana and Skunmun, 2002; Na-Chiangmai, 2002). Raising buffaloes appears to be more appropriate and profitable when the feeding level and feed quality are low, due to the species' efficient utilisation of low quality roughage, its low rate of feed passage through the digestive tract and its high number of rumen bacteria and fungal zoospores as compared to cattle (Indramangala, 2001; Poondusit, 2001). In addition, buffaloes are able to maintain body weight and condition during times of forage shortage due to their less selective grazing as compared to cattle (Chantalakhana, 2001).

5.6 Conclusions

Herding is an important feeding strategy practiced by resource-poor farmers to fulfil the livestock's nutrient requirements from external farm resources due to limited own pasture areas. An extensive feeding system is commonly practiced by the resource-poor farms, and especially the buffalo farms, which relies mainly on natural grasslands and communally used harvested crop fields while on-farm feed is of minor importance. As livestock production is intensified in such a system, off-farm feed resources become increasingly important. As inadequate feed supply is the predominant problem, feed quality is rarely considered by the farmers. Rice straw is a major feed supplement during lack of green forages. Variation of seasons, access to communal feed resources and crop residues as well as land use patterns affect to availability of feed supply of the low-input livestock farming. Therefore, improvement of communal and on-farm feed production as well as of crop residue utilisation should be implemented in order to overcome the feeding problems and ensure year-round feed supply.

CHAPTER 6

Herd structures and breeding practices on beef buffalo and beef cattle farms in northeastern Thailand

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Herd structures and breeding practices on beef buffalo and beef cattle farms in northeastern Thailand

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6.1 Abstract

The low productivity of Thai livestock is partly due to a limited genetic improvement. In order to foster genetic improvement, herd and breed composition, farmers' use of breeding services, strategies and goals, as well as their selection criteria for beef buffaloes and beef cattle were studied in the Nakhon Ratchasima province, northeastern Thailand. Between October 2007 and May 2008, 121 farmers were interviewed using a single-visit, multiple-subject survey to complete a pre-tested, semi-structured questionnaire. The herd size was on average 39.1 buffaloes (SD 39.7) and 41.8 cattle (SD 42.7) per farm, and seemed to be slightly higher than in previous years. Animals born within the herd were important for replacement in buffaloes, indicating a high risk of inbreeding, while cattle farms imported more breeding animals from off-farm sources. Artificial insemination (AI) was not practiced in buffaloes while cattle farms used both natural and AI services. Damage of the female's reproductive tract (38 % of responses) was mentioned as the most important constraint of AI. Traits related to beef production were stated as high priority for buffaloes, while cattle farmers preferred an attractive appearance. Owing to their beef production performance, Thai swamp buffaloes comprised up to 91 % of the herds. In cattle, crossbreds of native and Brahman, and of native, Brahman and Indo-Brazilian (88 % of herd) were appreciated for more attractive appearance compared to pure Thai native cattle (5 % of herd). Native cattle bulls were not included in breeding programmes, which may lead to the loss of genetic resources in local cattle in this area. Regionally adapted breeding extension services and programmes that build on farmers' participation are needed to improve livestock performance and consequently farm productivity, while conserving local animal genetic resources.

Keywords: Beef farming; Breeding objectives; Crossbreeding; Herd dynamics; Selection; Thailand

6.2 Introduction

The genetic improvement of buffaloes and cattle in Thailand has been successfully practiced on governmental stations for more than 30 years. It has generated benefits for the stations' herds (Vitoonpong and Rush, 2002). Unfortunately, smallholder livestock farmers are still limited in improving their farm productivity through appropriate breeding practices due to a lack of research and of breeding programme development at the farm level (Chantalakhana, 2001; Thummabood, 2002). On the village level buffaloes as well as cattle are randomly mated while grazing on harvested crop fields or community lands, reflecting the traditional breeding practices. The use of artificial insemination (AI) for buffaloes is limited while for cattle it is used more successfully, whereby especially exotic breeds are used (Na-Chiangmai, 2002). Exotic breeds are preferred over native cattle because of their body size, growth rates and prices (Chantalakhana and Skunmen, 2002; Intaratham, 2002). Lack of attention paid to animal breeding results in a low performance of the animals and a low productivity on smallholder farms (Chantalakhana and Skunmun, 2002; FAO, 2002). Against this background, the aim of this study was to assess the actual herd structure and demography, breeding services and goals, animal selection criteria and breed composition on beef buffalo and beef cattle farms in northeastern Thailand, Nakhon Ratchasima province, in order to determine shortcomings of breeding practices and identify possibilities for its improvement.

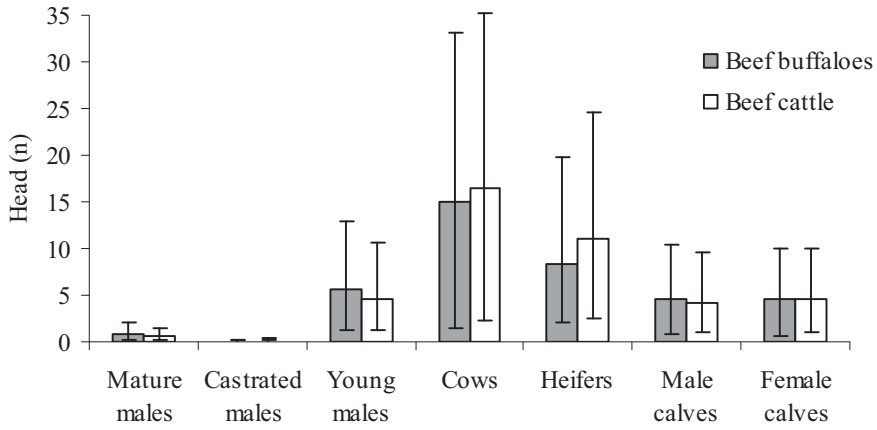
6.3 Materials and Methods

See Chapter 3

6.4 Results

6.4.1 Herd structure and demography

The average herd size on buffalo and cattle farms was 39.1 (SD 39.7, range 4 - 200) and 41.8 head (SD 42.7, range 3 - 200), respectively. Mature males accounted for 2.2 % and 1.6 % of the herd, while cows accounted for 39 % and 40 % of the buffalo and cattle herds, respectively (Figure 6.1). Large-scale farms kept more mature males (1.34 head) than medium-scale farms (0.75 head, $p<0.05$). Both differed significantly ($p<0.05$) from small-scale farms (0.29 head). However, the number of mature males was not different between buffalo and cattle farms.



Mature males = more than 3 years old; Young males = post-weaned to 3 years; Cows = after first calving; Heifers = post-weaned to first calving; Male and female calves = pre-weaned

Figure 6.1: Average number of animals per class as determined in 121 beef buffalo and beef cattle herds in northeastern Thailand, and 95 % confidence interval

During the twelve months preceeding the study, on average 10 animals entered and 8.5 animals left the farms (Table 6.1). Thus, the average herd size increased by 1.5 animals. Between farm sizes the number of animals entering (2.6, 7.9 and 20.2 animals in small-, medium- and large-scale farms) and leaving the farms (2.6, 5.9 and 17.5 animals in small-, medium- and large-scale farms) differed. The largest proportion of animals entering the farm constituted those born within the farms (90 %) whereas animals derived from other sources including purchasing, receiving as gift or heritage, and

exchanging with other farms or middleman summed up to a low proportion only (10 %). Averaging 2.1, 7.1 and 19.7 head, respectively, the number of animals born in small-, medium- and large-scale herds differed significantly between farm sizes ($p<0.05$). Cattle farms imported significantly more animals by buying (0.67 head) and exchanging (0.17 head) than buffalo farms (0.18 and 0.04 head, respectively).

Selling animals accounted for 79 % of all animals which left the farms, while 17 % died over the previous year. Animals given via non-market transactions as a gift or inheritance and exchanged with other farms only constituted a small proportion. The number of animals died, sold and given was significantly higher in large-scale farms (4, 12.5 and 0.88 head) than in medium- (1.1, 4.7 and 0 head) and small-scale farms (0.24, 2.3 and 0.07 head). Buffalo farms hardly exchanged their animals with other farms (0.04 head) compared to cattle farms (0.22 head, $p<0.05$).

Table 6.1: Herd dynamics in 121 beef buffalo and beef cattle herds in northeastern Thailand over a 12 months period (Oct 2006/May 2007 until Oct 2007/May 2008)

Herd dynamics, head (SE)	Beef buffalo farms			Beef cattle farms		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Entered animals						
Birth [a]	2.32 (0.3)	7.00 (0.6)	20.16 (3.5)	1.90 (0.2)	7.10 (1.1)	19.30 (1.8)
Purchasing [b]	0.09 (0.1)	0.25 (0.1)	0.21 (0.2)	0.65 (0.3)	0.90 (0.4)	0.45 (0.2)
Receiving	0 (0)	0.05 (0.1)	0 (0)	0.05 (0.1)	0.01 (0.01)	0 (0)
Exchanging [b]	0 (0)	0 (0)	0.11 (0.1)	0.10 (0.1)	0.30 (0.2)	0.1 (0.1)
Total [a]	2.41 (0.3)	7.30 (0.6)	20.47 (3.5)	2.70 (0.4)	8.45 (1.1)	19.85 (1.8)
Left animals						
Death [a]	0.27 (0.2)	1.45 (0.4)	3.42 (0.7)	0.20 (0.1)	0.65 (0.3)	4.55 (0.8)
Selling [a]	2.45 (0.4)	4.20 (0.6)	12.84 (2.6)	2.20 (0.5)	5.15 (1.1)	12.25 (1.9)
Giving [a]	0.14 (0.1)	0 (0)	1.05 (0.8)	0 (0)	0 (0)	0.70 (0.3)
Exchanging [b]	0 (0)	0 (0)	0.11 (0.1)	0.10 (0.1)	0.40 (0.2)	0.15 (0.1)
Total [a]	2.82 (0.4)	5.60 (0.8)	17.32 (2.4)	2.50 (0.5)	6.20 (1.2)	17.65 (2.0)
Herd balance	- 0.41 (0.5)	1.70 (0.7)	3.16 (4.1)	0.20 (0.6)	2.25 (1.2)	2.20 (2.6)

[a] Significant difference between herd sizes with ANOVA ($p\leq0.05$)

[b] Significant difference between beef buffalo and beef cattle with ANOVA ($p\leq0.05$)

6.4.2 Breeding services and sources of breeding stocks

AI was not practiced on buffalo farms, although 28 % of the farms had access to such services. Of cattle farms, one fifth were using commercial and/or government operated AI services (Table 6.2), although 95 % had access to such services. In 62 % of the buffalo farms, natural service was done by own bulls, while 38 % of the farms relied on bulls of neighbours. Cattle farms used natural services of own and neighbours' bulls at an equal share (40 % and 39 %, respectively). The larger the farm size, the more farmers used their own bulls for breeding (45 % of small- vs. 88 % of medium- vs. 100 % of large-scale farms, $p<0.05$). On the other hand, 90 % of the small-scale farms used bulls of neighbours, whereas the percentage for medium- and large-scale farms was only 48 % and 36 %, respectively ($p<0.05$). Large-scale farms kept more breeding bulls (1.16 head) than medium- (0.8 head) and small-scale farms (0.31 head) (SEM 0.09, $p<0.05$). Buffalo farms kept 0.86 breeding bulls, whereas cattle farms had on average 0.65 breeding bulls (SEM 0.07, $p<0.05$).

Damaging the reproductive tract of cows (38 % of responses) was the most important constraint of AI services mentioned by farmers, followed by unavailability (18 %), costs (17 %), indifference (12 %), unhealthy or poor calves (10 %) and inconvenience (5 %). Damages of the reproductive tract through AI was mentioned more frequently by cattle farmers (48 %) than by buffalo farmers (21 %, $p<0.05$), while lack of service and/or semen availability was stated more frequently by buffalo farmers (28 %) than by cattle farmers (5 %, $p<0.05$). Unhealthy calves obtained through AI was more often mentioned by small- (17 %) and large- (10 %) than by medium-scale farms (0 %, $p<0.05$).

Table 6.2: Breeding services and sources of breeding stocks of 121 beef buffalo and beef cattle farms in northeastern Thailand

Parameters	Beef buffalo farms			Beef cattle farms		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Breeding services, % of farms						
Own bulls (93) [1/, a, b]	63.6	100.0	100.0	25.0	75.0	100.0
Neighbour bulls (71) [b]	86.4	25.0	42.1	95.0	70.0	30.0
Commercial AI (9) [a]	0	0	0	20.0	15.0	10.0
Governmental AI (11) [a]	0	0	0	20.0	20.0	15.0
AI access, % of farms [a]	31.8	20.0	31.6	95.0	100.0	90.0
Breeding bulls, head (SE) [c, d]	0.36(0.12)	0.95(0.12)	1.26(0.13)	0.25(0.12)	0.65(0.12)	1.05(0.12)
Farmers' ideas to AI, % of farms						
No preference (13)	9.1	5.0	10.5	10.0	30.0	0
No service or semen (20) [a]	40.9	30.0	10.5	0	5.0	10.0
Expensive (19)	9.1	20.0	5.3	15.0	35.0	10.0
Poor calves (11) [b]	9.1	0	5.3	25.0	0	15.0
Reproductive harms (42) [a]	27.3	20.0	15.8	25.0	50.0	70.0
Difficult to manage (5)	0	15.0	5.3	0	0	5.0
Sources of male stocks, % of farms						
Own herd (41) [a, b]	59.1	60.0	47.4	10.0	10.0	15.0
Other farms (36) [a]	9.1	40.0	31.6	10.0	40.0	50.0
Middleman (31) [b]	9.1	15.0	47.4	5.0	35.0	45.0
Livestock markets (11) [a]	4.5	5.0	5.3	15.0	5.0	20.0
Sources of female stocks, % of farms						
Own herd (119)	100.0	100.0	100.0	90.0	100.0	100.0
Other farms (22)	9.1	15.0	10.5	40.0	25.0	10.0
Middleman (13)	4.5	5.0	10.5	10.0	25.0	10.0
Livestock markets (8) [a]	4.5	0	0	20.0	10.0	5.0

[1/] Number of responses

[a] Significant difference between beef buffalo and beef cattle with Fisher's Exact test ($p \leq 0.05$)

[b] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

[c] Significant difference between beef buffalo and beef cattle with ANOVA ($p \leq 0.05$)

[d] Significant difference between herd sizes with ANOVA ($p \leq 0.05$)

The majority of buffalo farms recruited breeding bulls from their own herd (63 % of buffalo vs. 18 % of cattle farms, $p<0.05$) while the main sources of cattle breeding bulls were other farms (50 % of cattle vs. 30 % of buffalo farms, $p<0.05$) and livestock markets (20 % of cattle vs. 6 % of buffalo farms, $p<0.05$). Small- and medium-scale farms preferred to keep young bulls born in their own herd for breeding compared to large-scale farms (36 % of small- and 35 % of medium- vs. 31 % of large-scale farms, $p<0.05$), while large-scale farms more often bought breeding bulls from middlemen than smaller farms (7 % of small- vs. 25 % of medium- vs. 46 % of large-scale farms, $p<0.05$). As far as the female buffaloes and cattle are concerned, 100 % and 97 % of farms recruited them from their own breeding stocks. Additionally, breeding females from other farms, middleman and livestock markets were alternatives. Compared to buffalo farms (2 %), females were more often bought at local livestock markets by cattle farms (12 %, $p<0.05$).

6.4.3 Breeding objectives and selection of replacing animals

As shown in Table 6.3, traits related to growth performance including body size and body condition (56 % of responses) were the most important objectives of buffalo and cattle farms in this area, followed by attractive appearance of animals (22 %). In contrast, traits related to farm management, namely feeding behaviour and temperament as well as reproductive performance and environmental adaptation (disease resistance and drought tolerance) were of minor importance. Compared to large-scale farms (64 %), small- (83 %) and medium-scale farms (83 %) preferred large body sizes ($p<0.05$). Cattle farmers paid more attention to animals' appearance, while buffalo farms preferred a friendly temperament.

The performance of the offspring (22 % of responses) was the most important trait for selecting buffalo and cattle breeding bulls, followed by a proper conformation (19 %) and a large body size and a good body condition (19 %) of the bull itself. Cattle farmers gave a higher priority to the performance of the offspring and to an "attractive" phenotype. On the other hand, buffalo farmers ranked beef production traits including the size and the body condition of breeding bulls higher. A proper feeding behaviour and temperament was more important for large- and medium-scale farms than for small-scale farms. On the contrary, small-scale farms preferred bulls with a large body size and a good body condition. Medium-size farms (25 %) considered attractive appearance of breeding bulls less important compared to small- (41 %) and large-size (59 %) farms ($p<0.05$). Good mothering abilities (25 % of responses) were given as the most important

trait for selecting females by buffalo as well as cattle farmers, followed by a good conformation, the body size and condition, the feeding behaviour and the temperament. An attractive appearance and mothering ability were more important for cattle than for buffalo farmers.

Table 6.3: Breeding objectives and selection traits of 121 beef buffalo and beef cattle farms in northeastern Thailand

Parameters	Beef buffalo farms			Beef cattle farms		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Breeding objectives, % of farms						
Attractive appearance (37) [1/, a]	27.3	20.0	15.8	50.0	40.0	30.0
Body size and condition (93) [b]	86.4	90.0	68.4	80.0	75.0	60.0
Feeding behaviour (27)	31.8	10.0	31.6	15.0	20.0	25.0
Temperament (9) [a]	18.2	15.0	5.3	0	0	5.0
Reproductive performance (13)	4.5	10.0	26.3	5.0	10.0	10.0
Adaptation (5)	4.5	5.0	0	0	0	15.0
Traits of male selection, % of farms						
Attractive appearance (50) [a, b]	9.1	5.0	36.8	75.0	45.0	80.0
Body size and condition (75) [a, b]	72.7	55.0	84.2	70.0	50.0	40.0
Conformation (77)	50.0	65.0	52.6	50.0	80.0	85.0
Feeding behaviour (43) [b]	13.6	50.0	36.8	15.0	50.0	50.0
Temperament (45) [b]	18.2	50.0	52.6	15.0	30.0	50.0
Reproductive performance (21)	9.1	15.0	26.3	5.0	20.0	30.0
Offspring's performance (87) [a]	45.5	75.0	68.4	80.0	90.0	75.0
Traits of female selection, % of farms						
Attractive appearance (17) [a]	4.5	10.0	5.3	40.0	10.0	15.0
Body size and condition (49)	40.9	50.0	57.9	30.0	15.0	50.0
Conformation (72)	59.1	55.0	47.4	55.0	70.0	70.0
Feeding behaviour (54)	31.8	40.0	52.6	65.0	40.0	40.0
Temperament (36)	22.7	30.0	21.1	45.0	40.0	20.0
Reproductive performance (17)	13.6	10.0	10.5	5.0	15.0	30.0
Offspring's performance (18)	13.6	25.0	5.3	5.0	15.0	25.0
Mothering ability (87) [a]	50.0	70.0	78.9	80.0	60.0	95.0

[1/] Number of responses

[a] Significant difference between beef buffalo and beef cattle with Fisher's Exact test ($p \leq 0.05$)

[b] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

6.4.4. Breed compositions

The major buffalo breed kept in the area was the Thai swamp buffalo (91 % of all responses), while river types such as Murrah, Mehsana and Nili-Ravi and their crosses with Thai swamp buffaloes were of low frequency (Figure 6.2). Swamp buffalo breeding bulls (84 % of bulls) and cows (91 % of cows) were mainly maintained in breeding herds, while river types were only sometimes incorporated.

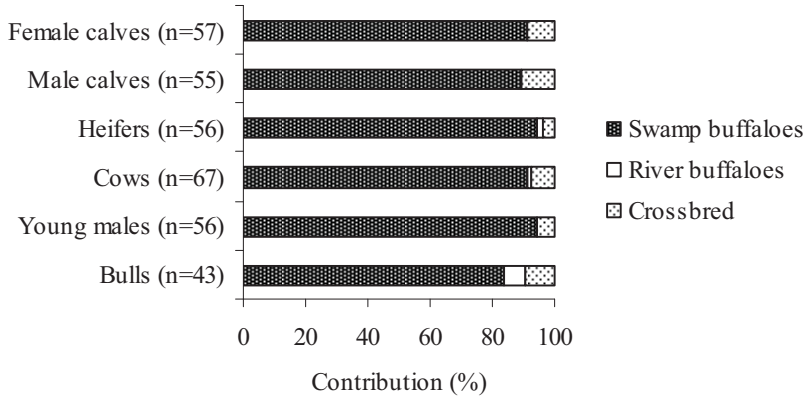


Figure 6.2: Breed contribution (% of responses) to 61 beef buffalo herds in northeastern Thailand (Numbers in parentheses = responses per animal group)

In the cattle herds, Thai native-exotic zebu crosses prevailed in the study area (Figure 6.3). Crossbreds between native and Brahman cattle (49 % of all responses) and between native, Brahman and Indo-Brazilian cattle (39 % of all responses) were the dominant genotypes, while pure native cattle were of low frequency (5 %). Native bulls were not used in breeding programmes whereas native-Brahman-Indo-Brazilian (54 %) and native-Brahman crossbred bulls (31 %) were predominantly used.

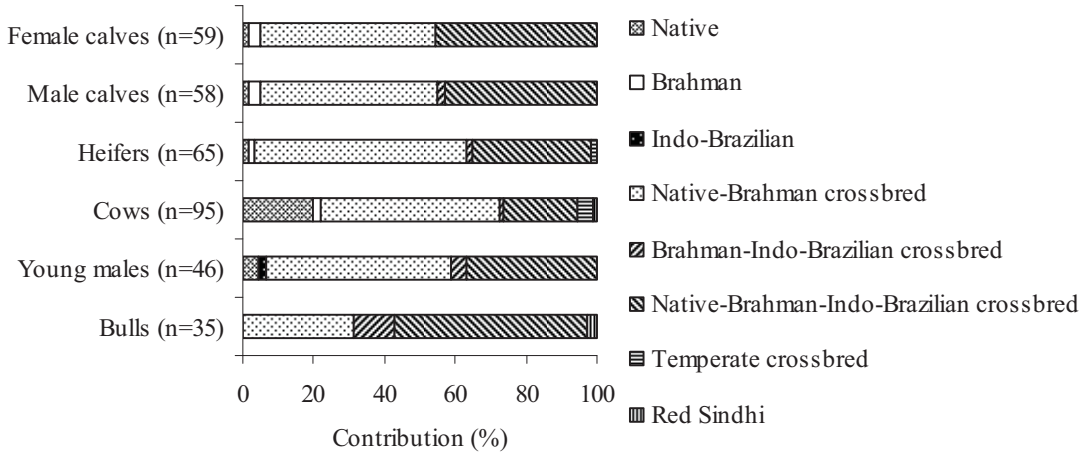


Figure 6.3: Breed contribution (% of responses) to 60 beef cattle herds in northeastern Thailand (Numbers in parentheses = responses per animal group)

6.5 Discussion

The herd sizes in beef buffalo and beef cattle holdings varied greatly between smallholders and large commercial herds in the studied area. The average herd size was large (39 buffaloes and 42 cattle) compared to data from nearby areas. For Surin province, northeastern Thailand, Skunmun et al. (2001) reported an average of 3 buffaloes and 4.6 cattle per farm. In southern Thailand, the average herd size was 9.9 to 11 buffaloes (Satchaphun et al., 2006; Punsawat et al., 2008). In the central region of Thailand, more than 90 % of farms were found to keep less than 15 head of cattle (Tumwasorn et al., 1996a). The relatively high numbers found in the present study may be explained by the fact that the availability of natural grasslands, forests and saline areas is relatively high, permitting more animals to be kept. Moreover, herd sizes in Nakhon Ratchasima province were also larger than in northern Vietnam (1.7 buffaloes and 2.0 cattle; Huyen et al., 2006) and the northern region of the Lao PDR (2.6 to 3.1 buffaloes and 2.8 to 5.8 cattle; Vongsamphanh et al., 2005). These differences might also be explained by differences in the production systems between the countries. Over the 12 months preceding our study, the number of animals kept on farms slightly increased. Births and sales accounted for the largest proportion of the herd population dynamics. The number of animals imported to cattle farms by purchasing

and exchanging with other farms was higher than on buffalo farms. This indicates a very limited gene flow on buffalo farms and a high level of relationship of buffaloes within a herd.

In the study area, only 62 % of the farmers kept their own breeding bulls. This is in agreement with results of Skunmun et al. (2001) who reported that mature male buffalo and cattle accounted for 0 % and 2 % of the population on smallholder farms in Surin province in northeastern Thailand. In Nakhon Si Thammarat province in southern Thailand (Punsawat et al., 2008), only 45 % of the buffalo farms kept mature bulls with an average of 0.6 per farm. The number of breeding bulls kept depends on the total number of animals raised on farm and the breeding services practiced by the farmers in this area. Small herds depended mainly on servicing bulls of neighbours, while large-scale farms mainly kept their own breeding bulls. These findings are in agreement with Chantalakhana and Skunmun (2002) and Na-Chiangmai (2002), who stated that very few smallholder farmers in Thailand keep a breeding bull due to a small number of effective females. Furthermore, in the present study, small-scale farms mostly recruited their own breeding stocks, whereas large-scale farms mainly imported animals from off-farm resources for replacement. As a result inbreeding is increasing in smallholder farms and also throughout the community caused by random mating and sharing breeding bulls.

Buffalo farms kept more breeding bulls than cattle farms, which is mainly due to the more diverse sources of breeding services claimed by cattle farms. Buffaloes born within the farm were the most important source of replacing stocks while cattle farms imported more of such animals from other sources by purchasing and exchanging. This points to a high risk of increasing the inbreeding level in the buffalo population. The result is similar to studies in southern Thailand, where 64 % (Satchaphun et al., 2006) and 70 % (Punsawat et al., 2008) of buffalo farms kept all females and males born within herds for breeding. These findings indicate that in both, buffalo and cattle farms, but particularly in smallholder buffalo farms, most of the replacing animals used are of unknown pedigree, although generally the genotype is known. Thus, systematic selective breeding is not possible. An increased level of inbreeding and the use of unproven bulls have negative long-term effects on productivity. The results are widely consistent with findings in various animal species and breeds (Bebe et al., 2003a; Jaitner et al., 2003; Mwacharo and Drucker, 2005; Dossa, 2007; Dossa et al., 2007; Paudel, 2009).

AI was not practiced by buffalo farms in the study area due to a limited supply of buffalo semen. In contrast, it was more available to cattle farms, although the acceptance by the farmers in the area was low. The most important constraint of AI stated by the farmers was the damage of the female's reproductive tract, followed by the poor availability and the high costs. The lack of effective AI service and promotion in this area partly limits the genetic improvement of the livestock, especially for buffaloes. Similar observations were made by previous studies: In southern Thailand, only 1 % (Satchaphun et al., 2006) and 2.7 % (Punsawat et al., 2008) of the buffalo farmers practiced AI. In the central region of Thailand, 79 % (Tumwasorn et al., 1995) and 70 % (Tumwasorn et al., 1996a) of cattle farmers had their cows artificially inseminated under the beef promotion projects of the government in Ang Thong and Uthai Thani provinces. Chantalakhana and Skunmun (2002) and Na-Chiangmai (2002) mentioned that using AI is limited on Thai buffalo farms, while it is quite successfully employed in cattle farms, especially when exotic breeds are used.

Farmers in this area considered traits related to beef production as high priority for buffaloes, while cattle farmers preferred an attractive appearance. Good looking cattle are expected to have high value through crossbreeding between native and exotic breeds such as Brahman and Indo-Brazilian which is commonly used on cattle farms in this area. On the other hand, buffalo farmers aim at gaining more money by selling marketable animals with high body weights while the appearance is of minor importance. In agreement with Indramangala (2001), buffalo raising for meat consumption is getting more important than for draught power. In practice, the performance of the offspring and the mothering ability were the most important criteria to select the breeding animals, particularly in cattle. The different preferences may be caused by the intensive breeding practices including the use of AI and the crossbreeding with exotic breeds on cattle farms. Small-scale farms gave a high priority to body size and condition in order to increase the income by selling few animals. Large-scale farms, on the other hand, considered traits related to farm management including temperament and feeding behaviour, such as neat and low selective grazing, as important. These traits are getting more important if the farmer keeps a large number of animals and practices a herding system based on communal resource use. These results indicate that the farmers try to meet their multiple goals as reflected by their breeding objectives and selection criteria which differ between animal species and between farming systems. In the southern region of Thailand, 30 to 36 % of the buffalo farms (Satchaphun et al., 2006; Punsawat

et al., 2008) practiced selection, which was mainly based on productive traits such as body size, growth rate and fertility.

The dominance of Thai swamp native buffaloes over river type buffaloes indicates the importance of the native buffaloes for the farmers in this area. In contrast, the cattle population mainly consisted of exotic zebu breeds (Brahman and Indo-Brazilian) and their crosses with native cattle. For cattle breeding native bulls were not used. The results are consistent with those of Satchaphun et al. (2006) from southern Thailand, where most of the farmers kept native swamp buffaloes (89 %) while only few farmers raised crossbreds. Similarly in Surin province, northeastern Thailand (Skunmun et al., 2001), swamp buffalo was the predominant breed (99.5 %). Farmers mentioned adaptation and performance as favourable traits of native swamp buffaloes compared to exotic buffalo breeds. Furthermore, in Surin province Skunmun et al. (2001) found that more than half (57 %) of the cattle were crossbreds (native and Brahman) at different blood levels while pure native cattle accounted for 43 % of the investigated population. Our results contrast many other studies which report that most cattle in Thailand are native cattle (Intaratham, 2002; Na-Chiangmai, 2002; Tongthainan, 2002; Khemsawat et al., 2003). In order to maintain the beef production potential as their breeding objective, buffalo farmers still include native swamp buffalo into their breeding programme whereas native cattle are replaced by exotic breeds with a higher growth potential and attractive appearance. Chantalakhana and Skunmun (2002) stated that within-breed breeding is commonly practiced in buffalo breeding in Thailand, whereas crossbreeding of native cattle with exotic breeds such as Brahman is common in cattle breeding. The results show that unplanned crossbreeding of exotic cattle with indigenous cattle has threatened the preservation of the native cattle breed in this area.

The share of breeding bulls by smallholders throughout the community makes controlled mating difficult. This requires the development of group breeding schemes with the full participation and long-term commitment of the livestock keepers (Mwacharo and Drucker, 2005). To develop a proper breeding programme, local farmers should be encouraged to participate in the development by giving them a forum for exchange of knowledge and experiences and for analyzing their problems and finding solutions, and providing them with relevant information and

training through the community-based management approach (Dossa, 2007). This strategy will enable the farmers to discover and enhance their own potential towards better breeding practices.

6.6 Conclusions

With regard to the high level of relationship of animals within the herd, uncontrolled mating and the use of unproved breeding bulls, the current reproduction management practices bear a high risk of increased inbreeding in the livestock farms, particularly in buffaloes. However Thai indigenous swamp buffaloes are still important in Thai farming because of their superior beef production potential compared to the river type buffaloes. On the other hand, cattle breeding includes various sources of genetic materials and applies modern breeding techniques in order to improve the attractive appearance of crossbred animals. Crossbreeding with exotic zebu breeds has induced a big change in cattle genetics, which may threaten the future existence of pure Thai indigenous cattle due to the unplanned crossbreeding and the lack of an effective breeding programme. An analysis and cautious reform of breeding programmes including farmers' participation might offer new chances for improving herd productivity and at the same time conserving the local genetic resources.

CHAPTER 7

Comparisons of beef buffalo and beef cattle farming in northeastern Thailand and their potential for further development

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Comparisons of beef buffalo and beef cattle farming in northeastern Thailand and their potential for further development

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7.1 Abstract

To determine the reasons for the decline of buffalo population in Thailand, causes for this phenomenon need to be addressed directly at the field level. Constraints and needs of the farmers, and community well being must be taken into account in initiatives for further developments of livestock farming. This study aimed at gathering such information from 121 beef buffalo and cattle farms of the Nakhon Ratchasima, northeastern Thailand using a semi-structured questionnaire during a single-visit, multiple-subject survey between October 2007 and May 2008. Farmers were convinced that buffaloes showed better adaptation to and productivity under extensive management compared to cattle. However, the lack of water resources was addressed as the most important reason for the decrease of buffalo farming (63 % of farmers), which was ascribed to suspected water contamination and community conflicts. As stated by the farmers, the deficiency of feed resources was the most significant constraint (61 % of farmers) and need for development (43 % of farmers). Although they sometimes caused social conflicts and environmental damages, animals were valued for improving soil fertility and the local ecosystem. Regarding their production potential, more attention should be paid to buffaloes by the government. The development of initiatives to improve on-farm and public feed and water management as well as livestock services and prices is needed by the authorities when market-oriented farming systems are to be developed. It will result in improved livestock farming, reduced community conflicts, protected natural resources and counteract the drastic decline of the local buffalo population.

Keywords: Common properties, Community conflicts, Development constraints, Livestock husbandry, Northeastern Thailand

7.2 Introduction

The livestock sector is only a relatively small part of the overall Thai agricultural sector. However, it is still important to develop it in terms of land use and job opportunities. Buffaloes, which mostly are of the swamp type, and cattle, are extensively kept mostly by smallholders that prevail in Thailand, especially in the northeastern region (FAO, 2002). The farms are small in terms of farm area and herd size with an average number of 4.8 buffaloes and 6.8 beef cattle per household in 2008. Between 1996 and 2008 the number of beef cattle increased from 6.2 to 9.1 million head while buffalo numbers declined from 2.7 to 1.4 million head (Khemsawat et al., 2003; DLD, 2008a), illustrating a trend of transition from buffalo rearing to cattle farming enterprises. As a matter of fact both animal species are complementary to each other and can also easily be integrated with crop production, but when farm resources are limited villagers opt for cattle instead of buffaloes when decisions have to be made because of the difference in heat tolerance (Skunmun et al., 2001).

Extensive grazing on communal land, harvested cropland and backyard pasture have been common practice in beef cattle and buffalo rearing throughout the country. Until recently when cropland has expanded and communal grazing land has been occupied for other purposes, forage shortage became a major constraint for livestock production systems in Thailand (Khemsawat et al., 2003). Moreover, social and environmental conflicts evolved due to the intensive use of public resources. However, livestock contribute substantially to rural households, improving farmers' income, land utilization and social status. In view of this, it is necessary to study and develop smallholder livestock production systems, among others through identification and diagnosis of farmers' needs through multidisciplinary and community-based approaches (Chantalakhana, 2001; Indramangala, 2001; Devendra, 2002a). Unfortunately, there is no specific extension programme and little research support for livestock production in Thailand, especially for buffaloes (Indramangala, 2001). This is due to the fact that beef animals are mostly raised by resource-poor farmers who have little or no influence on government or administrative decisions even though they play important roles in farming systems at household and community levels (Chantalakhana, 2001). To partly bridge this gap, the present study aimed at determining the reasons for the decrease of buffalo farming, and to investigate the social and environmental

impacts of beef buffalo and beef cattle farming along with the constraints and needs for their development at the farm level in northeastern Thailand.

7.3 Materials and Methods

See Chapter 3

7.4 Results and discussion

7.4.1 Comparisons of buffalo and cattle husbandry

The detailed livestock practices of the 121 farms are described in Table 7.1. Solid housing (sound structure and solid materials) was more frequently offered to cattle (77 %) than to buffaloes (51 %, $p<0.05$). 42 % and 32 % of the housing systems for buffaloes and for cattle, respectively, were simple ones (simple structure and local materials, $p<0.05$) while they were not different across herd sizes. Three small and one large buffalo herd had no barn at all. Local materials such as bamboo, tree branches and wood, which were collected in the area, were combined with some modern materials such as barbed wire, steel pipe and electric fence for building the housing. Cattle farms invested relatively more in farm facilities when compared with buffalo farms. Water containers, feed containers, mosquito nets, holding pens and holding chutes were used by 73 %, 37 %, 8 %, 8 % and 15 % of the cattle farms compared to 23 %, 2 %, 0 %, 0 % and 2 % of the buffalo farms, respectively ($p<0.05$). 63 % of the cattle farms supplied pasture lands for their animals while only 28 % of buffalo farms had their own pastures ($p<0.05$). Vaccinations (90 % and 74 % of cattle and buffalo farms, respectively) and treatments against internal parasites (88 % and 72 % of cattle and buffalo farms, respectively) were usually practiced by the farmers in this area, but significant differences existed between the animal species ($p<0.05$). Furthermore, some cattle farms (3.3 % and 1.7 %) but no buffalo farm practiced branding and dehorning while there was no significant difference in farm facility provision and practices between sizes of herds ($p>0.05$). These findings indicate that the buffalo farmers practice a very extensive management system when compared to the cattle farms. However low-input farming systems are widely practiced by either smallholder or large-scale herd farms.

Table 7.1: Farm facilities and management on beef buffalo and beef cattle farms in northeastern Thailand

Farm facilities and management	Beef buffalo farms (n=61)	Beef cattle herds (n=60)
Livestock housing, % of responses [a]		
Solid housing (77) [1/]	50.8	76.7
Simple housing (40)	42.6	23.3
No housing (4)	6.6	0
Farm facilities, % of farms		
Water containers (58) [b]	23.0	73.3
Feed containers (23) [b]	1.6	36.7
Mosquito nets (5) [b]	0	8.3
Holding pens (5) [b]	0	8.3
Holding chutes (10) [b]	1.6	15.0
Pasture lands (56) [b]	27.9	63.3
Farm managements, % of farms		
Internal parasite treatment (97) [b]	72.1	88.3
External parasite treatment (93)	70.5	83.3
Vaccination (99) [b]	73.8	90.0
Castration (5)	4.9	3.3
Branding (2)	0	3.3
Dehorning (1)	0	1.7

[1/] Number of responses

[a] Significant difference between buffalo and cattle with χ^2 test ($p \leq 0.05$)

[b] Significant difference between buffalo and cattle with Fisher's Exact test ($p \leq 0.05$)

These results are in accordance with findings of a study in Nakhon Si Thammarat province, southern Thailand, where among 150 buffalo farms 23 % supplied no and 66 % supplied simple housing, while only 10 % constructed solid housing (Punsawat et al., 2008). Similarly, most of the farmers (97 %) had no pasture land and external (27 %) and internal (39 %) antiparasitic treatments were rarely practiced by the farmers (Punsawat et al., 2008). In four different provinces of the southern part of Thailand, however, Satchaphun et al. (2006) found that among 142 buffalo farms 74 % and 70 % practiced vaccination and internal antiparasitic treatments, respectively. The similar level of management in cattle farms is confirmed by some previous reports. In Ang Thoung province, central Thailand (Tumwasorn et al., 1995), the cattle farmers constructed good housing conditions with roof (73 %), mosquito nets (70 %) and chute and corral

(75 %). Similarly, 57 % and 88 % of the farmers practiced parasite treatment and vaccination (Tumwasorn et al., 1995). In Uthai Thani province, central Thailand, Tumwasorn et al. (1996a) found 88 % and 96 % of beef cattle farmers practiced deworming and vaccination. Beef production in Thailand is mostly practiced in rural areas where the farmers generally keep animals in temporary housing in the backyard as a traditional extensive production system (Na-Chiangmai, 2002). In the country's northeastern region, the greatest variation of livestock husbandry and management practices is found (Indramangala, 2001). These variations are due to the natural conditions of the grazing areas, the crop production systems, economic settings, farming systems and farmers' lifestyle.

7.4.2 Favourable traits of beef buffaloes and beef cattle stated by the farmers

Perceptions of the different characteristics between swamp buffaloes and crossbred cattle (Native-Brahman or Native-Brahman-Indo-Brazilian) as given by 121 livestock keepers are given in Table 7.2. Many positive characteristics of buffaloes were mentioned by both buffalo and cattle farmers, including high fertility, longevity, suitable feeding behaviour such as neat and little selective grazing, high feed intake, good body condition, large body size, high meat production, friendly temperament and high market value. Although all of these attributes were also mentioned for cattle, the respective percentages of responses were significantly lower ($p<0.01$). On the other hand, also cattle were commended by their keepers as well as by buffalo keepers for advantageous characteristics including high drought tolerance, heat tolerance, favourable meat and attractive appearance of the animal; in these aspects the positive responses for cattle outnumbered those for buffaloes ($p<0.01$). Disease and parasite resistance, growth rate and easy sale were of equal importance in buffaloes and cattle.

Table 7.2: Perception of 121 beef buffalo and beef cattle farmers in northeastern Thailand of the favourable characteristics of the animals

Favourable traits	Farmers' perception, % of responses		χ^2 test
	Swamp buffaloes	Crossbred cattle [1/]	
Fertility	86.0	14.0	**
Longevity	83.3	16.7	**
Drought tolerance	10.3	89.7	**
Disease resistance	57.1	42.9	n.s.
Parasite resistance	60.4	39.6	n.s.
Heat tolerance	0.8	99.2	**
Suitable feeding behaviour	100	0	**
High feed intake	97.1	2.9	**
Growth rate	47.8	52.2	n.s.
Good body condition	89.2	10.8	**
Large body size	85.5	14.5	**
Meat production	95.6	4.4	**
High favourable meat	29.6	70.4	**
Friendly temperament	77.9	22.1	**
Attractive appearance	7.8	92.2	**
Easy sale	60.8	39.2	n.s.
High market value	70.7	29.3	**

[1/] Native and Brahman crossbred or Native, Brahman and Indo-Brazilian crossbred

** Significant difference between buffalo and cattle ($p \leq 0.01$); n.s. not significant

As mentioned by most farmers, the swamp buffaloes are praised on their superior potentials for beef production, their reproductive performance, and higher value of marketable beef animals compared to the crossbred cattle. Some scientists point out inappropriate comparisons of lower buffalo production and reproductive performances than exotic cattle breeds. The reasons for this probably are mismanagement in buffalo breeding practices such as lack of bulls, neglect to mate females during working period, and they are compared across different farm managements (Indramangala, 2001). Under the same environment, Chantalakhana (2001) stated that growth rates and meat quality as well as reproductive efficiency of beef buffaloes and Brahman cattle are quite comparable. Buffaloes are known to digest poor-quality roughages such as crop residues and by-products more efficiently than cattle due to larger gut capillaries, slower passage of feed

through the rumen and a higher degree of rumen fermentation due to a higher number of rumen bacteria and fungal zoospores (Indramangala, 2001; Poondusit, 2001). Cattle require good quality feeds to achieve a high growth rate while buffaloes are more efficiently utilizing low quality roughages and water plants since they are less selective grazers than cattle. Moreover, buffaloes are able to maintain a good body condition during the dry and hot summer as long as wallows or rivers are available when cattle usually lose much body weight (Chantalakhana and Skunmun, 2002). In an experiment focusing on feedlot performances, Poondusit (2001) reported that crossbred beef cattle (50 % Charolais, 25 % Brahman, 25 % Thai breed) and dairy bulls (Holstein Friesian > 75 %) grew faster than Thai swamp buffaloes. However, the cost of fattening per kg body weight was the lowest for swamp buffaloes. Moreover, buffaloes contributed more meat than cattle and their meat was lean, tasty and often undistinguishable from beef (Indramangala, 2001; Nanda and Nakao, 2003). In the study of Sheikh et al. (2006) conducted in the floodplains of the Amazon River, the ranchers stated that buffaloes had a greater productivity than cattle, were better adapted to the floodplains' environmental conditions, easier to manage, and more profitable than cattle. According to these authors, buffaloes have steadily gained acceptance as an alternative to cattle, and throughout South America buffaloes perform favourably in both beef and dairy production (Sheikh et al., 2006). Buffaloes impress their keepers by their high production potential under wetland conditions regarding to their high resistance to common diseases, superior weight gain than cattle, high quality dairy and meat products, and the ability to fatten on a wide range of grasses.

7.4.3 Community and environmental impacts caused by livestock farming

More than half (63 %) of the interviewed livestock farmers had experienced some sort of conflict in their community during the past 5 years of the study (Table 7.3). Crop plantation was mentioned as the most important source of conflicts with livestock farming (67 % of responses). This was especially true for the large herds (69 %) and only to a lesser extend for the small (60 %) and medium (40 %) herds ($p<0.05$). Use of public water resources was mainly causing conflict for buffalo farms (18 %) compared to cattle farms (5 %; $p<0.05$). Conflicts due to grazing of communal and unused land (15 % of responses) and other activities such as use of streets as animal track, violation to use protected forests, fishing, dirtiness to nearby neighbours

and local authority (altogether 5 % of responses) were also experienced by the farmers. However, 37 % farmers had no conflicts with any sector of their communities. The findings indicate that community conflicts often occur when animals are kept in high density on farms and their production mainly relies on the use of limited public resources. The restricted size of public grazing land requires more effort to closely look after the animals as they may damage crops. Moreover, pesticide or herbicide application to the crops is dangerous for nearby grazing livestock (Simaraks et al., 2003). According to Sheikh et al. (2006), buffaloes in the floodplains of the Amazon River played an important role in conflicts between landowners. Their keeping introduced changes to the floodplain environment and was interfering with activities such as fishing and crop farming. The main antagonists in almost half of all conflicts were fishermen (58 % of responses). Other conflicts emerged between buffalo ranchers and their neighbours (26 % of responses), nearby farmers (5 % of responses) and the community (11 % of responses; Sheikh et al., 2006).

In the present study, only 21 % of farmers mentioned some negative impacts of livestock farming on the local environment and 19 % of farmers mentioned complaints from neighbouring households related to their livestock during the past 5 years (Table 7.3). Livestock manure and urine as cause of dirtiness were a significant problem in the communities (67 % of responses) and were also subject to complaint by neighbouring households (48 % of responses) in terms of sanitation problems, more often caused by buffaloes than by cattle farms ($p<0.05$). Furthermore, water contamination was mainly caused by buffalo farming while this impact was never mentioned for cattle farms ($p<0.05$). Some farmers also stated other impacts of livestock on communities and environment such as erosion of river banks, dust, noisiness and odour. However, the majority of farmers mentioned that their livestock did neither have any effect on the community and local environment (79 %), nor lead to any conflict with their neighbours (81 %) during past 5 years.

Table 7.3: Impacts of livestock farming on community and environment during the last 5 years of the study as stated by 121 livestock farms in northeastern Thailand

Parameters, % of answers	Beef buffalo farms			Beef cattle farms		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Social conflicts						
Crop plantation (68) [1/, a]	54.5	40.0	73.7	65.0	40.0	65.0
Communal and uncultivated lands (15)	4.5	20.0	26.3	5.0	15.0	5.0
Public water resources (14) [b]	18.2	20.0	15.8	5.0	5.0	5.0
Other activities [2/] (5)	0	0	5.3	5.0	5.0	10.0
Neighbour complaints						
Water contamination (1)	4.5	0	0	0	0	0
Bank erosion (2)	4.5	0	0	0	5.0	0
Dust (4)	0	5.0	10.5	0	5.0	0
Noise (1)	0	0	5.3	0	0	0
Odour (7)	0	10.0	0	10.0	5.0	10.0
Dirtiness (14) [b]	22.7	5.0	26.3	5.0	5.0	5.0
Community and environmental impacts						
Water contamination (6) [b]	13.6	10.0	5.3	0	0	0
Bank erosion (1)	4.5	0	0	0	0	0
Dust (1)	0	0	5.3	0	0	0
Odour (1)	0	0	0	0	5.0	0
Dirtiness (18)	9.1	25.0	10.5	15.0	20.0	10.0
Farmers' perception of environmental benefits of livestock production						
Soil improvement (121)	100.0	100.0	100.0	100.0	100.0	100.0
Crop waste utilisation (4)	0	5.0	5.3	5.0	5.0	0
Forest area preservation (8)	0	5.0	21.1	0	5.0	10.0
Water quality improvement (4)	0	0	10.5	0	0	10.0
Fish feeding provision (3)	0	0	10.5	0	0	5.0

[1/] Number of responses

[2/] Protected forests, fishing, neighbours, local authority

[a] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

[b] Significant difference between buffalo and cattle with Fisher' Exact test ($p \leq 0.05$)

From our results, buffaloes probably create community problems and environmental harms due to their dung and urine dropping on community places and in water resources when compared with cattle. High competition for land use is related to herd size. However, only a low number of the farmers in this area are involved in these conflicts. Simaraks et al. (2003) mentioned that raising livestock in a densely populated village will create uneasy circumstances and disturb neighbours, depending on the number of animals and their manure. The landless livestock keepers are almost totally dependent on common property resources for grazing. It probably causes increase of land degradation from overgrazing and erosion (Devendra, 2002a), due to heavy pressure on grazing land by inappropriately managed livestock. On the other hand, well-managed animals should not degrade the environment and the natural resource (Chantalakhana and Skunmun, 2002).

In our study, all farmers mentioned that soil fertility improvement is a very important benefit of livestock husbandry (Table 7.3). Further benefits of livestock farming such as crop residue utilization, forest area conservation, water quality improvement and nutrient inputs by applying livestock manure to fish ponds and other aquaculture holdings were appreciated by farmers. Several authors reported that animal production offers an opportunity to appropriately use land unsuitable for cropping, conserve forest areas and render them more productive (Chantalakhana, 2001; Chantalakhana and Skunmun, 2002; Kawashima, 2002). This is also true for agricultural land, where livestock allow for the transfer of nutrients from areas of lower returns from cropping to those of higher returns, accelerate nutrient turnover in the production cycle and reduce nutrient losses in the system compared to agricultural production without livestock integration. Compared to the unique use of mineral fertilizers, crop-livestock integration enables farm households to increase their agricultural production without depleting their natural resource base (Devendra, 2002b; FAO, 2002; Tipraqsa et al., 2007). Large ruminants can utilize low quality feeds such as rice straw, a residue presently mostly burnt in northeastern Thailand. This wasteful practice creates environmental pollution and sometimes causes serious accidents. Animal grazing under perennial tree crops can control weeds and reduce the costs of herbicide use and the risk of environmental contamination. Furthermore, the introduction of improved forage species for ruminants can make an important contribution to erosion control by providing cover, and to increased soil fertility by enhancing soil nutrient and organic matter concentrations (Devendra

and Thomas, 2002c). Livestock manure applied in bulk can improve soil texture, promote better absorption of moisture, reduce run-off and prevent crusting of soil surface. Moreover, livestock manure can be used to fertilize fishponds, and manure addition to natural water bodies can fertilize and increase aquatic populations of fish, crabs and aquatic insects which may be used as human food (Simaraks et al., 2003).

7.4.4 Constraints and needs of livestock farms

Livestock production constraints in the study region as mentioned by the interviewed beef buffalo and beef cattle keepers are shown in Table 7.4. The most important constraint for both farming systems was the lack of forage resources (mentioned by 61 % of farmers). Low price for the marketable animal was also of importance, particularly in cattle farms (62 % vs. 35 % of buffalo farms, $p<0.05$). Lack of water resources and cause for social conflicts were important constraints for large-scale farms (36 % and 20 %, respectively) compared with 7 % and 2 % of small-, and 18 % and 15 % of medium-scale farms, respectively ($p<0.05$). Some farmers mentioned the lack of capital and family labour, disease and health problems, and lack of government services and supports as well.

Farmers' requirements for improved livestock farming (Table 7.4) are mainly related to the livestock production constraints mentioned before. More communal properties including pasture lands and water resources were reclaimed by 43 % of the farmers. Most of the large-scale farms (67 %) asked for extension of common properties, while this issue was of lower importance in small- (33 %) and medium- (30 %) scale farms ($p<0.05$). Livestock prices, government services, health and disease control, and investment promotion were other needs raised by 28 %, 28 %, 18 % and 12 % of the farmers, respectively. Farmers keeping cattle (43 %) were especially interested in higher livestock prices when compared to buffalo keepers (13 %), which points to the major constraint of cattle farming as mentioned before. In addition, 43 % of the medium-scale farms showed an interest in higher livestock prices compared to 22 % and 21 % of small- and large-scale farms, respectively ($p<0.05$). Some farmers expected that the government should pay more attention to livestock marking development, availability of livestock husbandry training programmes, farmer cooperation and establishment of a conservation programme for native animal breeds in order to develop the regional livestock production.

Table 7.4: Constraints and needs of livestock farming, and farmers' perception of reasons for decreasing buffalo numbers in northeastern Thailand

Parameters, % of answers	Beef buffalo farms			Beef cattle farms		
	Small (n=22)	Medium (n=20)	Large (n=19)	Small (n=20)	Medium (n=20)	Large (n=20)
Livestock production constraints						
Disease and health problems (7) [1/]	13.6	5.0	0	0	15.0	0
Forage resources lack (74)	45.5	65.0	68.4	55.0	55.0	80.0
Water resources lack (24) [a]	13.6	20.0	47.4	0	15.0	25.0
Community conflicts (15) [a]	4.5	10.0	21.1	0	20.0	20.0
Low animal prices (58) [b]	31.8	40.0	31.6	55.0	65.0	65.0
Capital and labour lack (15)	13.6	5.0	26.3	20.0	5.0	5.0
Government services and support lack (5)	0	5.0	5.3	0	10.0	5.0
Farmers' needs for development						
Health and disease control (21)	4.5	20.0	31.6	20.0	10.0	20.0
Communal property share (52) [a]	31.8	40.0	63.2	35.0	20.0	70.0
Higher livestock prices (34) [a, b]	9.1	25.0	5.3	35.0	60.0	35.0
Efficient livestock marketing (6)	0	10.0	5.3	0	10.0	5.0
Government services (34)	31.8	40.0	21.1	30.0	20.0	25.0
Investment promotion (15)	27.3	0	21.1	10.0	15.0	0
Farmer cooperation (3)	4.5	0	0	0	5.0	5.0
Livestock training programmes (4)	0	5.0	0	0	10.0	5.0
Livestock conservation efforts (1)	0	5.0	0	0	0	0
Farmers' perception of reasons for decreasing buffalo farming						
Lack of water resources (76)	63.6	45.0	73.7	55.0	70.0	70.0
Managing difficulties (6)	4.5	5.0	5.3	15.0	0	0
Low fertility and growth (7)	0	10.0	5.3	10.0	5.0	5.0
Lack of promotion and investment (19)	22.7	35.0	5.3	10.0	10.0	10.0
Conflicts and environmental impacts (29)	27.3	20.0	21.1	25.0	25.0	25.0
Low animal prices (31)	27.3	35.0	21.1	25.0	15.0	30.0

[1/] Number of responses

[a] Significant difference between herd sizes with χ^2 test ($p \leq 0.05$)

[b] Significant difference between buffalo and cattle with Fisher's Exact test ($p \leq 0.05$)

Feed availability becomes a major constraint and need of the livestock production in this area especially with a very high density of animals on farms. This corresponds to findings of Khemsawat et al. (2003) and due to the fact that land available for agricultural purposes is very limited due to increased population pressure and government policies that have reclassified some land into national parks and have quarantined other regions from further agricultural development (FAO, 2002). Devendra (2002a) also points to nutrition and health being the main technical constraints in Asia's livestock production. Improvement of availability and quality of animal feed would reduce the pressure on common property resources and thus the risk of their degradation (Devendra, 2002b). There is no standard price for beef cattle and markets are not well developed. Furthermore, the beef produced in Thailand is not up to export standards because of poor beef processing procedures and facilities (FAO, 2002). The meat sold for local consumption and to the meat processing factories is normally processed at the local abattoir where the live animals are purchased directly from the villagers. Those animals are priced per head by individual appearances, depending on the size of the animal. The fresh meat is sold to the butcher at prices per kilogram carcass weight and then to the local consumers; thus, a doubling of the price between farm gate and consumer can be observed (Na-Chiangmai, 2002).

The present results are in accordance to a study of Punsawat et al. (2008). The most important problem of buffalo farming in Nakhon Si Thammarat, southern Thailand was the lack of forage followed by inefficiency of livestock marketing, lack of investment, disease spread and infertility. On the other hand, in four other southern provinces of Thailand (Satchaphun et al., 2006), livestock marketing and investment (56 %) and breed improvement (41 %) were addressed by buffalo farmers as the most urgent needs followed by farm management improvement and disease control. In contrast to that, the most important problems for 135 cattle and buffalo keeping farm households in northern Thailand (Kehren, 1999) were foot and mouth disease (39 %), leg injuries (14 %), limited availability of food (8 %) and weight loss (7 %). Beef cattle and buffalo farmers in four villages in northeastern Thailand mentioned high market prices, better spread of local livestock markets and more easily available loan sources as possible opportunities for livestock raising development (Simaraks et al., 2003). For two villages in the Surin province in northeastern Thailand, Skunmun et al. (2001) reported that 72 % to 80 % of the villagers asked for government action in support of buffalo farming, so as to help farmers to either increase their

animal numbers or return to buffalo rearing. Some of the respondents in Surin province suggested that large-scale buffalo rearing should be promoted as a commercial production scheme. Campaigns promoting the use of buffaloes on small farms in rain-fed rural areas as practiced previously were also favoured by the farmers in the two villages. Overall, the different studies illustrate the large variation of constraints and the specific needs for the development of livestock farming, which depend on the regions and the animal species.

7.4.5 Reasons for buffalo farming decline

Many reasons for the decrease of buffalo farming were given by the interviewed 121 farmers (Table 7.4). Both buffalo and cattle farmers (63 %) alike stated the lack of water resources being the most important reason for this development. Wallowing areas in mudholes or other water resources are very important for buffalo farming because in hot environments buffaloes regulate body temperature by wallowing (Chantalakhana, 2001; Skunmun et al., 2001). However the presence of buffalo farming simultaneously leads to the contamination of the water resources, especially if buffaloes are kept in high density. This problem is not occurring in cattle husbandry (Table 7.3), and it seems to be the major reason for the decline of the buffalo population in the study area (mentioned by 24 % of farmers; Table 7.4). Cattle are therefore the first choice of farmers to keep on farm when a decision needs to be made between the two species (Skunmun et al., 2001). Low prices for the animals were mentioned by 26 % of the farmers as a possible reason for the declining buffalo farming in this area, followed by lack of government promotion initiatives and investments. Further reasons were low fertility and slow growth of buffaloes as well as management difficulties (shading and wallowing need during mid-day). Before 2000, the price of live buffaloes in Thailand was only about half of that of cattle. Only recently, the prices of live cattle and buffaloes have become more comparable (Chantalakhana, 2001).

The possible reasons of decreased buffalo farming possibly vary among the respective areas and production systems. In two villages of Surin province in northeastern Thailand (Skunmun et al., 2001), three principal reasons the abandonment of buffalo rearing were most importantly the lack of family labour, secondly the sale of buffaloes for cash to cover household expenses and thirdly the use of hand-driven tractors for land preparation. In addition some villagers mentioned the

availability of off-farm employment, the lack of grazing land as well as complete exit from the agricultural sector as reasons for the abandonment of buffaloes (Skunmun et al., 2001). Chantalakhana (2001) mentioned that there is a sharp decrease in the number of buffaloes in Thailand, possibly leading to an erosion of genetic material due to socio-economic changes, high slaughter rates, scarcity of farm labour, lack of grazing areas, lack of breeding bulls, the increasing use of small tractors, inefficient livestock marketing systems and low market prices, as well as neglect by research, development and promotion.

7.5 Conclusions

In the studied area livestock, particularly buffaloes, are kept in an extensive production system. Since mainly communal pastures and water resources are used, resource-poor livestock farms often strongly compete for these assets, which may lead to social conflicts and environmental harms. Limited availability of communal resources is thus the most important constraint of livestock farming. In particular the lack of water resources along with the prohibition of wallowing in public or private water sources is seen as the major reason for the decreasing number of buffalo farms. However, despite sometimes causing environmental pollution, farmers acknowledge livestock's contribution to maintain the local ecosystem. Under extensive conditions, buffaloes are valued for their higher meat production potential and greater promise for substantial production compared to cattle. However, improved communal and on-farm livestock feed and water management as well as livestock marketing, attractive and stable prices, and supporting government services are needed if commercial livestock farms should gain importance over the subsistence system. This might also reduce social conflicts, lower environmental hazards, increase ecological benefits and counteract the steep decrease of Thailand's buffalo population.

CHAPTER 8

General discussion, conclusions and recommendations

General discussion

8.1 Buffalo and cattle production systems

A high proportion of the buffaloes and cattle in the study region were integrated in mixed crop-animal farming systems (Chapter 4). This is the traditional system of the Thai agriculture, in which various kinds of plants and animals are integrated. With the integration of plants and animals different advantages are associated. The production risk is minimized, sources of income are diversified, food security is provided, labour and land productivity is increased, and sustainability is enhanced (Devendra and Thomas, 2002a; Paris, 2002). Moreover, the diversification of agricultural commodities can help to reduce problems of market fluctuations and economic uncertainty. Several studies have shown that mixed crop/animal farming systems continue to be productive and sustainable for rural livelihoods (Chantalakhana and Skunmun, 2002; Devendra and Thomas, 2002c). In accordance with other studies conducted in southern provinces of Thailand (Satchaphun et al., 2006; Punsawat et al., 2008) and in Dan Khun Thot district in Nakhon Ratchasima province (Suppadit et al., 2006), the present study found that livestock farms were operated by aged farmers who had a long experience in livestock farming. Household activities were mainly done by family members and hired labour is limited. The farm sizes were small with 7.9 ha in average and less than half of the area was used for livestock production. A low-input, low-output farming system was widely practiced by the resource-poor farmers, especially on buffalo farms, in terms of farm management, farm facilities, feed supply, feed supplementation as well as breeding practices (Chapter 5, 6 and 7). It is known that these traditionally managed small-sized farms are characterized by low capital input; limited access to resources; low levels of economic efficiency; diversified agriculture and resource use. The farmers are usually conservative and illiterate, living on the threshold between subsistence and poverty. The access to new technologies is very limited (Devendra and Thomas, 2002a).

8.2 The importance of buffaloes and cattle

Buffaloes and cattle played a very important role for the farmers as reported in Chapter 4. The most important reason for keeping the animals was the generation of income particularly in terms

of wealth accumulation, buffering and insurance functions, and covering of household expenses. Besides the financial functions, the improvement of the social status was another important function of the livestock. The traditional uses of livestock including draught power, source of manure, inherited asset and conservational aspect were rarely mentioned. The results indicate that the role of livestock have changed from being part of the subsistent agricultural system to market-oriented production aiming at income generation. The benefits of livestock have been reported by several studies for different farm species and in different areas. Skunmun et al. (2001), Simaraks et al. (2003), Satchaphun et al. (2006) and Suppadit et al. (2006) studied beef cattle and buffalo raising in other areas of Thailand, Dossa et al. (2007), Dossa et al. (2008) and Ouma et al. (2003) analyzed in goat, sheep and cattle raising in Africa, and Sheikh et al. (2006) and Siegmund-Schultze et al. (2007) studied cattle and buffalo raising in the Amazon region. Livestock are known as “saving bank”, “living bank”, “walking bank” or “living stocks” due to their roles for the rural farmers who have limited access to commercial banks and institutional credits (Chantalakhana, 2001; Indramangala, 2001; Sheikh et al., 2006; Siegmund-Schultze et al., 2007). Siegmund-Schultze et al. (2007) found that in the Eastern Amazon cropping was more profitable than cattle production. However, cattle could be sold at any time if cash was needed (Siegmund-Schultze et al., 2007). Ouma et al. (2003) assessed the non-market benefits of cattle across open grazing, semi - zero grazing and zero grazing systems in Kenya. The farmers valued the non-market benefits of cattle to approximately 20 % of the animal’s total value. Between the various production systems the non-market benefits varied (Ouma et al., 2003).

Buffalo and cattle raising was able to cover the largest proportion of household expenditures consisting of both expected and emergency cases as shown in Chapter 4. The results show that with increasing farm size, dwelling conditions, household assets and access to commercial health insurances were better. The benefits of livestock for the livelihoods of the farmers are in agreement with Siegmund-Schultze et al. (2007) who focused on the roles of cattle for mixed small-scale farms in Eastern Amazon. The socio-cultural acceptance and valuation of cattle production was high. Owing cattle increased the self-consciousness and the status of the small-scale farmers in the region. Cattle allowed innovative farmers to invest and to generate large amounts of capital. Cattle were the best option for large and flexible cash reserves, improving the livelihood of farmers (Siegmund-Schultze et al., 2007). In southern Benin, Dossa et al. (2008)

confirmed the financial role of goats and sheep for poor rural households who had no access to credits and had few opportunities for off-farm income. Increasing individual income, financial independence, and bargaining power while overcoming financial bottlenecks within the family were the obvious benefits expected from keeping small ruminants (Dossa et al., 2008). If the opportunity was given, farmers in Colombia would like to keep cattle, but the lack of cash and grazing area were major constraints. They expected to improve their quality of life by owing cattle as a tool for saving and generating capital (Holmann et al., 2005). In the rain-fed areas in Asia there is widespread poverty and concerns of equity and food insecurity. Animals are often the main means of income generation and livelihood improvement (Devendra, 2002a).

8.3 Husbandry of beef buffaloes and beef cattle

8.3.1 Feed resources and feeding management

Due to very low availability of cultivated pasture, feed supply for the livestock, especially large-scale herds in the studied area was mainly coming from off-farm resources (Chapter 5). Communal property resources were very essential for the resource-poor farms to fulfil their livestock's requirement by using a herding system while cultivated pastures were of low importance. In the rainy season, native grasslands and forests were mainly used for grazing, because the cropping fields were cultivated with cash crops. During the dry season after harvesting community-owned crop fields became the most important source. The dependence on the communal resources, the variation of cropping patterns, accessibility and seasonal differences result in a lack of forage and a low quality of feed. As also stated by Devendra and Thomas (2002b,c) this is the major limitation of feed allocation on the livestock farms. Therefore, for the farmer it was not possible to feed green forages to the animals over the whole year. This was also observed for buffalo raising in the Mid-hills of the Western Development Region of Nepal (Paudel, 2008). As stated by Paudel (2008) this was the most important constraint for livestock farmers and resulted in the need to use communal resources (see Chapter 7). The importance of sharing communal properties for livestock farming is reported from several areas in Thailand (Skunmun et al., 2001; Simaraks et al., 2003; Satchaphun et al., 2006; Punsawat et al., 2008) and from different countries in Africa (De Jode et al., 1992; Mwacharo and Drucker, 2005).

Rice straw was the major supplement during feed shortage or throughout the whole year while concentrate supplementation was rarely practiced by the farmers in the studied area. This is consistent with other studies conducted in Thailand (Kehren, 1999; Skunmun, 2001; Chantalakhana and Skunmun, 2002; Devendra and Thomas, 2002a,b,c; Simaraks et al., 2003). Although low nutrient content and digestibility is widely known as the major limitation of rice straw the farmers in this area were hardly concerned about this limitation. None of the farmers used any treatment to improve its quality. This is due to the fact that the accessibility and availability of rice straw are still limited as also observed by Paudel (2008) in Nepal. Rice and wheat straw with poor quality and without any treatment was the major feed source for buffaloes. Feeding practices of livestock farms vary among areas depending on agro-ecological zones, availability of forage sources, cropping patterns and climatic fluctuations. Devendra and Thomas (2002a) stated that climatic, edaphic and biotic factors influence the feasibility of cropping and the type of crops. This, in turn, determines the quantity, quality and distribution of animal feed resources throughout the year. Devendra (2002a) mentioned that crop residues, agro-industrial by-products and non-conventional feed resources have to be utilized more effectively and efficiently. An extensive feeding management is predominant in livestock farming in the studied area, particularly on buffalo farms. While buffalo farms relied mainly on native grasses from natural resources, cattle farms cultivated pastures with improved grasses and supplemented roughages and concentrate feeds. The differences between buffalo and cattle farming reflect the farmers' statement that buffaloes are more properly fed than cattle (Chapter 7). It is widely known that buffaloes digest poor-quality and high cellulose containing roughages more efficiently than cattle and have a wider range of grazing preferences including even water plants (Tulloch, 1974; Indramangala, 2001; Chantalakhana and Skunmun, 2002; Na-Chiangmai, 2002).

8.3.2 Breeding systems and practices

The size of beef buffalo and beef cattle farms varied from small- up to large-scale farm enterprises (Chapter 6). The existence of small-scale farms was investigated by Skunmun et al. (2001) in Surin province, Northeast, by Tumwasorn et al. (1996a) in Central and by Satchaphun et al. (2006) and Punsawat et al. (2008) in South Thailand. The distribution of the farm sizes is due to the differences in availability of communal resources and in production systems. In

contrast to large-scale farms, small-scale farms recruited breeding animals from their own herds and also used breeding bulls of their neighbours. Cattle farms usually used replacement animals from off-farm resources, whereas buffalo farms rarely preferred imported animals. Similar results were found in two villages of Surin province in northeastern Thailand by Skunmun et al. (2001) and in southern Thailand by Satchaphun et al. (2006) and Punsawat et al. (2008). Furthermore, this is widely consistent with the findings of similar studies in Africa (Bebe et al., 2003; Jaitner et al., 2003; Mwacharo and Drucker, 2005). The results imply that systematic selective breeding is lacking because most of the bulls used are of unknown pedigree and an uncontrolled mating system is practiced by the farmers. Increased inbreeding, particularly on small-scale buffalo farms, and the use of unproven bulls are likely to have unfavourable long-term effects on productivity through the degradation of the herd genotype. Moreover, the use of AI was not well adopted by the livestock farmers in this area. In particular, buffalo farms did not use AI. The ineffective AI service is the major limitation of Thai rural farmers to access and adopt AI. Consequently the genetic improvement of the livestock in this area is very limited. This is consistent with studies in South Thailand (Satchaphun et al., 2006; Punsawat et al., 2008).

Traits related to growth performance were rated as most important by the farmers in this area. For buffalo farmers a large body size and a good body condition were given a high priority, while for cattle farmers an attractive appearance was very important. The results are in agreement with the differences of favourable traits between buffaloes and cattle addressed by the farmers (Chapter 7). Cattle farmers expect high value of animals with an attractive appearance. This is a reason why they preferred to cross their cattle with Indo-Brazilian cattle. In contrast, buffalo farmers only focus on the body weight. A large body size was especially important for small-scale farmers who expect to get a higher income by selling few marketable animals. For large-scale farmers, traits related to farm management were rated higher. This implies that breeding practices of the livestock farms reflect the goals of farmers which are responding to the production systems and livestock species. In South Thailand, only a low proportion of buffalo farmers selected breeding cows based on productive traits such as large body size, high growth rate and fertility (Satchaphun et al., 2006; Punsawat et al., 2008).

The Thai swamp buffalo was predominant on buffalo farms in this area while native-exotic zebu cattle crossbreds such as Brahman and Indo-Brazilian were the major breeds of beef cattle farms. This implies the importance of Thai swamp buffaloes and their role for traditional breeding practices (Chapter 6). If managed properly, the swamp buffalo has a high potential for meat production, perhaps the highest of all buffalo breeds (Cockrill, 1974). On the other hand, Thai native cattle are going to become extinct due to unplanned crossbreeding with exotic breeds. The farmers' preference of Thai swamp buffaloes is consistent with studies in South Thailand (Satchaphun et al., 2006) and in Surin province, northeastern region of Thailand (Skunmun et al., 2001). On the other hand, the breed composition of beef cattle is different to other studies which report that most cattle in Thailand are native breed (Intaratham, 2002; Na-Chiangmai, 2002; Tongthainan, 2002; Khemsawat et al., 2003). Crossbreeding is useful if it is well planned and managed, and farmers' experiences, socio-economic and market conditions, and farm practices are considered. In order to achieve the intended objectives and to protect and conserve indigenous breeds, it should be monitored (Chantalakhana and Skunmun, 2002). As the study of Waritthitham (2010) showed, crossing Thai native cattle with exotic breeds such as Brahman and Charolais resulted in the improvement of beef production and beef quality under feedlot management in Northern Thailand.

8.4 Comparisons between buffaloes and cattle

In the studied area, buffaloes were managed more extensively compared to cattle (Chapter 4, 5, 6 and 7). This reflects that buffaloes are known for their higher adaptation and productivity under a low-input production system (Chapter 7). Other important factors to keep buffaloes are their higher beef production potential, fertility, longevity and market value compared to cattle. As stated by Cockrill (1994) cited by Chantalakhana (2001) and Nanda and Nakao (2003) "Of all domestic animals, Asian buffaloes hold the greatest promise and potential for production". Many authors agree in the superior performances of buffaloes over cattle (Chantalakhana, 2001; Indramangala, 2001; Nanda and Nakao, 2003; Sheikh et al., 2006). Some scientists pointed out that the comparisons of the productivity of buffaloes and exotic cattle breeds are inappropriate, but studies have indicated that buffaloes' productivity is remarkably high when compared under the same harsh conditions (Chantalakhana, 2001; Indramangala, 2001). Under controlled

fattening conditions (Poondusit, 2001), buffaloes showed the lowest growth rate compared to dairy bulls and crossbred beef cattle. However the cost of fattening per kg body weight was lowest for buffaloes. Indramangala (2001) stated that buffalo infertility has been noted as a major concern. This is usually caused by mismanagement, e.g. lack of bulls or neglects to mate productive females during working time. However, due to the low heat and drought tolerance compared to cattle (Skunmun et al., 2001; Chantalakhana and Skunmun, 2002), buffaloes need special management such as shading and wallowing and/or swimming in water resources under hot climate conditions.

8.5 Reasons for the decreasing buffalo population

The unavailability of water resources was addressed by farmers as the most possible reason for the decreasing buffalo population in this area, mainly because public water resources are limited and buffaloes are a cause of water contamination (Chapter 7). Due to the fact that buffalo farming was accused as a possible cause of water contamination and community conflicts, the access of buffaloes to public and private water resources was sometimes banned. Buffaloes are known as having fewer sweat glands on the body skin compared to cattle. Thus, they usually reduce heat stress by lying and swimming in water (Chantalakhana, 2001; Skunmun et al., 2001). With the presence of buffalo farming, the contamination of the water resources increases, especially when buffaloes are kept in high density. If private and/or public water resources are limited and the access for buffaloes is banned, farmers do not have the possibility to raise buffaloes. Another important factor for the decline of the buffalo population stated by the farmers was the low price for buffaloes. High slaughter rates of buffaloes over the past 15 to 20 years resulted in prices being lower for buffalo than for cattle. The price of live buffaloes was only about half of the price of cattle, mainly due to the high demand of breeding cattle for crossbreeding programmes. At the same time the beef price of buffaloes and cattle was more or less the same (Chantalakhana, 2001). In general, butchers prefer buffaloes because the proportion of red meat is higher (Indramangala, 2001). Only a couple of years before this study, the prices of live cattle and buffaloes had the same level. Other reasons for the decline of buffalo farms were the lack of promotion and investment programmes of the government, the low productivity of buffaloes and the need of special management regarding their low heat tolerance. Other studies report various

reasons for this development in Thailand (Chantalakhana, 2001; Indramangala, 2001; Skunmun et al., 2001; Chantalakhana and Skunmun, 2002; Nanda and Nakao, 2003) including the increasing agricultural mechanization, the urbanization and industrialization, farmers' debts, the lack of household labour, grazing area, and breeding bulls, the attitude of the young generation towards buffalo raising, the lack of suitable government policies, socio-economic factors and the difference in heat tolerance between cattle and buffaloes.

8.6 Relationship between livestock farming, community and environment

Due to the high competitive land use, cropping was stated by livestock farmers as the major activity having conflicts with livestock farming (Chapter 7). This was particularly mentioned by large-scale farmers, because of their lower area allowance and because their feed supply depended mainly on external farm resources (Chapter 5). The limitation of community-owned grazing areas makes it necessary to look closely after the animals, as they might damage crops. Moreover, the application of pesticides or herbicides to the crops is dangerous for nearby grazing livestock (Simaraks et al., 2003). Buffalo farming was related to conflicts about public water resources, water contamination and community sanitation problems caused by wallowing and manure in the water resources and on roads. It is believed that this unique manner of buffaloes is either a conditioned reflex or an attempt to identify territory (Tulloch, 1974). This conflict was related to the lack of water resources as stated by the farmers as the most important reason for the decline of the buffalo population in this area. Raising livestock in a densely-populated village results in conflicts with neighbours. These conflicts increase with an increased animal density (Simaraks et al., 2003). In the floodplains of the Amazon River, Sheikh et al. (2006) found that buffaloes were prone to altering the floodplain environment and interfering with production activities such as fishing and farming. Livestock has been accused of causing degradation of natural resources such as land and forest, as well as pollution and social antagonism.

However, animal production under good management will not degrade the environment and natural resources as well as human well being (Chantalakhana and Skunmun, 2002; Devendra, 2002b). As found in the present study, several benefits of livestock farming on the society and the local environment were mentioned, including soil and water improvement, efficient use of crop

wastes, conservation of forest areas and provision of feed for aquatic animals. Many studies agree on these social and ecologic benefits of livestock farming as an important component of agriculture, particularly in mixed farming systems (Chantalakhana, 2001; Chantalakhana and Skunmun, 2002; Devendra , 2002a,b; Devendra and Thomas, 2002c; FAO, 2002; Kawashima, 2002; Simaraks et al., 2003; FAO, 2007; Tipraqsa et al., 2007).

8.7 Constraints of livestock farming and its prospects for further development

In order to initiate livestock development programmes, problems and needs of farmers should be investigated. The lack of forage resources was the most important constraint of livestock production mentioned by almost all farmers in the studied area (Chapter 7). This was mainly due to the fact that the farm sizes were small and a high proportion of the land was used for cropping (Chapter 4). Thus, feed supply for the animals in this area depended mainly on off-farm resources (Chapter 5). The results are consistent with other studies which stated that feed availability became a major constraint for livestock production throughout Asia (Devendra, 2002a; Khemsawat et al., 2003). The low price of live animals also was another important constraint particularly mentioned by cattle farmers, because of differences of the market value between buffaloes and cattle. At the time of the study, the price for cattle has decreased, because the demand for breeding stock used for crossbreeding decreased, whereas for buffaloes it was stable. Furthermore, the farmers in this area stated many urgent needs for the development of livestock farming. The access to community-owned pastures and water resources was demanded by most farmers, especially large-scale farmers. In contrast the livestock price was of high concern for cattle farmers. There is no standard price for beef and markets are not well developed. The beef produced in Thailand has not the standard which is necessary for export because of poor beef processing procedures and facilities (FAO, 2002). Other needs mentioned by the farmers were the lack of capital and family labour, disease and health problems, and the lack of government services and supports.

The results are similar to a study of Punsawat et al. (2008) conducted in Nakhon Si Thammarat province, southern Thailand. The most important problem of buffalo farming was lack of forage followed by the inefficiency of livestock marketing, the lack of investment, disease disperse and

infertility (Punsawat et al., 2008). On the other hand, in the other four southern provinces, Satchaphun et al. (2006) found that livestock marketing and investment and breed improvement were addressed by buffalo farmers as the most urgent needs, followed by the improvement of farm management and disease control. In northern Thailand, Kehren (1999) reported that the most important problems for cattle and buffalo raising were FMD, leg injuries, limited availability of feed and weight loss. In four villages of northeastern Thailand (Simaraks et al., 2003), beef cattle and buffalo farmers stated to need higher market prices, wider spread of local markets and more available loan sources as opportunities for livestock development. In Dan Khunthod district, Nakhon Ratchasima province, Suppadit et al. (2006) recommended ways of improving the extension of Good Agricultural Practices (GAPs) in beef cattle farming including seminars and training of livestock farming, cooperation establishment between government and farmers, development of a long-term plan and improvement of government promotion and services on beef cattle production. These show a great variation of constraints and needs of livestock farming development in different areas and in different production systems.

General conclusions

The role of buffaloes and cattle has changed from traditional farming practices towards beef farming enterprises aiming at the generation of household income and to obtain buffering and insurance functions for rural households. Although livestock farming plays a very important role for household livelihoods, livestock is still raised under extensive management in low-input, low-output production systems. Feed supply for the animals depends on external resources and varies with the availability of communal property resources, the variability of season and climate, and the cropping patterns. Genetic improvement of livestock is still very limited due to a high risk of inbreeding, the use of unproved breeding bulls and the lack of efficient breeding programmes. Unplanned and uncontrolled crossbreeding is going to threaten the existence of Thai indigenous cattle. The Thai swamp buffalo is still important but an effective program for its genetic improvement is needed in order to diminish inbreeding and improve the genetic potential. Although buffaloes have a high potential for beef production compared to cattle, management practices for the buffaloes are still primitive, traditional and archaic. Their population has decreased due to the lack of water resources for wallowing, cause of water contamination and

community sanitation problems as well as decreasing buffalo prices. Therefore, the use of communal and on-farm feed and water resources has to be improved in order to increase farm productivity, to reduce social and environmental conflicts and to counteract the decline of the buffalo population. Furthermore, the improvement of the livestock marketing system, animal prices and government services should be intensively considered by the authorities when market-oriented farming enterprises gain importance. This might also support the sustainable development of the local beef production and consequently improve the farmers' livelihoods.

Recommendations

According to the outcomes of this research, the following recommendations are given in order to improve the beef buffalo and beef cattle production systems in northeastern Thailand and as a consequence to improve farmers' socio-economy and livelihoods:

1. The seasonal differences in feed supply and its synchronization with animal requirements throughout the year should be intentionally concerned by researchers. The use of common property resources should be well managed and on-farm feed production programmes should be improved and promoted to achieve a high and effective feed supply and at the same time to avoid excessive exploitation of natural resources. Various crop residues and by-products have to be utilized more effectively and efficiently.
2. Breeding improvement programmes should be carefully designed by including farmers' opinions, considering farmers' experiences in farming, socio-economic and market conditions. The programmes should ensure the preservation of the genetic resources of native breeds. The government should monitor crossbreeding and methods to maintain genetic diversity in domestic animals should be implemented in order to conserve farm animal genetic resources.
3. The Thai government should pay more attention to the development of the buffalo production and focus on their potential for beef production. To the use of public water resources and the development of on-farm water management should be paid more attention in order to impair the decline of the buffalo population, to reduce social and environmental conflicts and to promote large-scale beef buffalo farm enterprises.

4. Livestock production in the future must take into account the environmental and community impacts in order to protect the environment from excessive exploitation and the society from conflicts related to livestock farming both in the short and long term. This aspect should be concerned not only by government but also by farmers.
5. Researchers must have direct contact to farmers and access the real understanding of the existing farming systems by using the community-based management approach and inter-disciplinary research that takes all aspects of farm management into account. On-farm research has to involve all stakeholders, diagnose initial problems, and pay serious attention to the economic and socio-cultural dimension.
6. As the most important reason for raising beef animals is the generation of income, the government should pay more attention to promote modern farm husbandry, to improve governmental services, to develop livestock marketing systems as well as to sustain attractive and stable livestock prices in order to improve farm productivity and as a consequence to enhance the standard of living of the farmers.

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