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**Use of draft and working animals  
in agriculture of Vietnam**

**Bachelor Thesis**

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## **DECLARATION**

I hereby declare that I have written presented bachelor thesis “Use of draft and working animals in agriculture of Vietnam” by myself with help of the literature listed in references.

Prague 30<sup>th</sup> April, 2013

.....  
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## **ABSTRACT (EN)**

### *Use of draft and working animals in agriculture of Vietnam*

This bachelor thesis contains analyzes the use of animals for agricultural development. Vietnam has been moving towards a market economy and modernization of agriculture. The rate of use of mechanization in agriculture is increasing; however, animals are used primarily on small farms. More than 50% of the total agriculture areas in Vietnam are still cultivated by draft animals, while only about 30% are cultivated by mechanization. The soil preparation by draft animals positively effects on yield and quality of agricultural crops. There are many ways to use the power of draft animals.

The pulling power of animals is used to reduce the effort and time consumption of farmers, especially in areas with a complex terrain - hills, mountains, terraced fields; it prevents the use of mechanization and leads the farmer to use draft animals to facilitate movement of goods, water, crop residues and fertilizer while reducing the risk of environmental pollution.

Although the Vietnamese agriculture is still facing with many problems, which are caused by very different work intensity and traditional cultural characteristics of each region; the energy of draft animals is the most suitable for small farms. Water buffalo remains the dominant large mammals reared on small farms in Vietnam. This results in low environmental impact and low energy consumption, which meets the criteria of sustainable development.

**Key words:** agricultural crops, soil preparation, animal husbandry, terraced fields, water buffalo

## ABSTRACT (CZ)

### *Využívání tažných a pracovních zvířat ve vietnamském zemědělství*

Bakalařská práce obsahuje analýzy týkající se využití zvířat v zemědělství. Vietnam nyní směřuje k tržní ekonomice a modernizaci zemědělství. Míra použití mechanizace v zemědělství se zvyšuje, ale zvířata se dále používají především na malých farmách. Více než 50% z celkové zemědělské plochy je ve Vietnamu stále obděláváno s pomocí zvířat, zatímco jen asi 30% mechanizací. Příprava půdy tažnými zvířaty pozitivně ovlivuje výnos a kvalitu plodin. Existuje mnoho možností, jak využívat síly tažných zvířat.

Tažná síla zvířat slouží ke snížení námahy a pracnosti pro zemědělce, speciálně v těch oblastech, kde komplexní terén - kopce, hory, terasovitá pole – brání nasazení mechanizace a vede farmáře k používání tažných zvířat s cílem usnadnit pohyb zboží, vody, zbytků po sklizni a hnojiv a zároveň snižuje riziko znečištění životního prostředí.

Ačkoliv se Vietnamské zemědělství stále potýká s mnoha problémy způsobenými velmi odlišnou intenzitou práce a tradičními kulturními charakteristikami každého regionu. Vodní bývali zůstávají dominantními velkými savci chovanými na malých farmách ve Vietnamu. To má za následek nízký environmentální impact, nízkou energetickou náročnost, což splňuje kritéria trvale udržitelného rozvoje.

**Key words:** zemědělské plodiny, zpracování půdy, živočišná výroba, terasovitý terén, vodní býval

## **LIST OF ABBREVIATIONS**

<b>ASEAN</b>	Association of South East Asian Nations
<b>ASEM</b>	The Asia-Europe Meeting
<b>ADB</b>	Asian Development Bank
<b>CIA</b>	Central Intelligence Agency
<b>CULS</b>	Czech University of Life Sciences
<b>DA</b>	Draft working animals
<b>DAFE</b>	Department of Agricultural and Forestry Extension
<b>EALAF</b>	East Asia-Latin America Forum
<b>FAO</b>	Food and Agriculture Organization
<b>FDI</b>	Foreign Direct Investment
<b>GDP</b>	Gross Domestic Product
<b>IBRD</b>	International Bank for Reconstruction and Development
<b>IFAD</b>	International Fund for Agricultural Development
<b>ICAO</b>	International Civil Aviation Organization
<b>IFC</b>	International Finance Corporation
<b>IMF</b>	International Monetary Fund
<b>IDA</b>	International Development Association
<b>IMF</b>	International Monetary Fund
<b>LPDR</b>	Lao People's Democratic Republic
<b>MARD</b>	Ministry of Agriculture and Rural Development (Vietnam)
<b>MIGA</b>	Multilateral Investment Guarantee Agency
<b>SEA</b>	South - East Asian
<b>UNCTAD</b>	United Nations Conference on Trade and Development
<b>UNIDO</b>	United Nations Industrial Development Organization
<b>UNDP</b>	United Nations Development Program
<b>WB</b>	World Bank
<b>WTO</b>	World Trade Organization

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# 1. INTRODUCTION

Advanced science and technology are changing the world with astonishing speed. However, developing countries mainly have an agricultural economy, and industrialization has only recently started. One of the most important conditions determining the success of modernization and industrialization is modern machinery investment in agriculture, which is widespread in developing countries. Vietnam is one of the middle-income countries, and agriculture became important although Vietnam is innovative. It is still an agricultural economy and society where three-quarters of the population lives in the rural areas and more than half of the labor force works in agriculture.

Draft animals are used in the agricultural system to create an interaction between plants and animals. Animal power, which uses a green plant material as a resource, can be considered as a renewable form of energy, and thus can save fossilized energy while reducing pollution. Farmers do not have many choices in the small farms, where animal power is used mainly at work.

Draft animals are not only important contributors for the agricultural sector, and they are also very important in rural transport. The using of draught animal power in agriculture has stimulated the social evolution of rural populations. It provides the means for smallholder farmers to access modern cultivation equipment. This often leads to a sustainable development system, whereas agricultural mechanization uses motorized machines. This may have drawbacks. In some cases, they can't use tractors in places such as terraces, valleys, rivers, or muddy areas in small farms, where the farm owners aren't sufficient for funding or investment. So the use of animal power in agriculture is necessary.

Water buffaloes are numerically the most important draught animals, in small farms in Vietnam, particularly in the wetter, more humid areas. Also, they are used to work in a variety of different operations. In small farms in Vietnam, farmers use draft animals as the main energy sources for agriculture.

Swamp buffalos are raised by small farm holder in Vietnam for multipurposes in agricultural production. Buffalo population is more than 2.9 million and mostly

distributed in the Northern Mountainous and Upland areas (52%) (Do Kim, 2009). Local swamp buffalo have low meat and milk productivity and poor reproductive performance however, it is well adapted to poor feeding and hot humid climatic condition. Swamp buffalo plays an importance role in total agriculture production and economic income of small farm holder. It is the main source of drought power in cultivation of crop and paddy rice field preparation, the main fertilizer and meat supply for small farm holder in mountainous area. Buffalo can utilize crop residue, rice straw and weeds better than cattle and transform it in to high food quality for human consumption.

In Vietnam, swamp buffalo and its role in agricultural system is considered for a long time. Buffalos are used to work in a variety of different operations. The main constraint for buffalo production as late mature, low conception rate, long gestation period, long calving interval and low reproductive efficiency. To improve buffalo production in Vietnam, there is need to apply new technology in breeding, feeding and management system.

## 2. LITERATURE REVIEW

### 2.1 VIETNAM

The agricultural development involves closely with economic growth and economic development. In order to outline the appropriate theoretical framework, it is necessary to mention some basic data about Vietnam, its climate, agriculture and especially about usage of draft animals (mainly buffalos) in agriculture.

**Figure 1:** Map of Vietnam



**Official country name:** The socialist  
Republic of Vietnam

**Capital:** Hanoi

**Population:** 92,477,857

**Climate:** tropical in the south,  
subtropical in the north

**GDP:** \$3,500

**HDI:** 0.617 (UNDP, 2012)\*

Source: CIA, 2013  
\*UNDP, 2012

### 2.1.1 Geography and climate descriptions

Vietnam is situated in Southeast Asia, with an area of 330,000 km<sup>2</sup> and a population of 92 million inhabitants (CIA, 2013). The population growth rate is 1.5 % per year and this makes Vietnam a densely populated country with about 220 persons per km<sup>2</sup>. Vietnam stretches over 15 latitudes, from 8°30' to 23°30' N, so the climate varies and differs distinctly from the north to the south. It is bordered on the north by China, on the west by Laos and Cambodia and on the south and east by the South China Sea (see Fig. 1). The country is 1,650 km long from north to south with a coastline of 3,260 km and an area of 3,730 km<sup>2</sup> inland border. There are two major river deltas - the Red River Delta (Delta River Hong) in the north and the Mekong Delta (Delta River Cuu Long) in the south. More than three quarters of Vietnam's territory comprises mountains and hills. Fan Xi Pan Peak (Phan Xi Phang), with a height of 3,143 meters, is considered the roof of Indochina. To the south, it is the Mekong River and its fertile plain that governs the geography and consequently the rice industry. Among the plains, in the middle of the thin country and to the southwest are mountainous areas, known as the highlands, where farmers grow rubber, tea and coffee (FAO, 2010).

There are two major climate regions in Vietnam. Northern Vietnam has a highly humid tropical monsoon climate with four distinguishable seasons. Southern Vietnam has a rather moderate tropical climate given the weak influence of monsoon and is characterized by dry and rainy seasons and warm weather all year round. The average temperature in Vietnam varies between 21°C and 27°C and increases from the North to the South. The average rainfall each year stands between 1,500 mm and 2,000 mm. Air humidity is 80%. For coastal areas and the parts of the central highlands facing northeast, the season of maximum rainfall is during the south monsoon, from September to January. The weather at this time is cloudy with frequent drizzle. During the north monsoon, northern Vietnam has cloudy days with occasional light rain, while southern Vietnam tends to be dry and sunny (CIA, 2013).

Vietnam is often prone to natural disasters such as storms, floods and droughts. Vietnam's soil is diverse with high fertility, thus providing very favorable conditions for the development of agriculture and forestry. Vietnam is also endowed with abundant and diverse flora, including 14,600 species of vegetation. From North to South, Vietnam

can be divided into 7 agro-ecological zones, based on topography soil pattern and climate, three in the North (The Northern Mountain and Midlands, the Red River Delta and the North Central coast) and four in the South (the South Central Coast, the Central Highlands, the South East, and the Mekong River Delta). Currently, in the Statistical system, the North Mountain and Midland is divided in North - West and North - East zones that make up 8 agro-ecological zones. Nevertheless, with 3/4 of total area is mountainous region, it is narrow from mountain to sea, the slope patent is high thus in the dry season many parts of the country are facing shortage in fresh water (from November to April) (FAO, 2010).

### **2.1.2 Society and Population**

Vietnam has 54 different ethnic groups. In which 53 of those are minorities and take 14% of Vietnam's population. Vietnamese, also called Kinh (or Việt), make up 84% the population percentage. Their population is concentrated in the alluvial deltas and coastal plains of the country (Dang et al., 2000).

Vietnam is the 2<sup>nd</sup> most population country in South East Asia, seventh in the Asia - Pacific. With a population of over 92 million (estimated in 2013), Vietnam is the 14<sup>th</sup> most populous country in the world. Hanoi and Ho Chi Minh city are two the most populous cities in Vietnam. The rapid population growth (see Fig. 2) is a serious obstacle for the economic development of the country (CIA, 2013).

Vietnam has succeeded initially in parturition rate from 6.1% in 1960 to 3.7% in 1994. This is government's investment in health care and education. The reason for being stuck at 3.7% and 2.2% for the growth rate was Vietnam had to face with the war and economic stagnation after the end of the Indochina War in 1975. An investigation of reproduction and sex education shows that most women in Vietnam get married before 20, leads to the high birth rate, state encourages: "every family should have only one or two children" (Do Trong, 2004).

**Figure 2: Vietnam population**



Source: Tradingeconomics, 2013.

### 2.1.3 Economy

After years of war and since 1986, the government launched the *đổi mới* (“renovation”) or all-round renovation process, stepping in the general development trend and the process of gradual globalization and regionalization. With top priority being given to economic reform for creating a multi-sector market economy regulated by the government, at the same time consolidating legal environment and renovating Party’s and State’s structure. Then the Vietnam’s economy became opened and it has transformed from centralized planned economy heavily based on imports. All aimed at budget balancing and promoting exports (Nguyen Co, 1989).

As from 1989, Vietnam began to export about 1 - 1.5 ton of rice. The inflation rate gradually decreased the rate stood at 67.4% in 1990 (Vo Hong, 2006).

During the 1991-1995 period, the economic growth rate (presented by the increase rate in GDP) reached 8.2%. By June 1996, Foreign Direct Investment (FDI) reached over \$ 30.5 billion; inflation decreased from 67.1% (in 1991) to 12.7% (in 1995) and 4.5% (in 1996) (Vo Hong, 2006).

After a long negotiation process, Vietnam became a full member of ASEAN in 1995 and was accepted into membership of the WTO since 11 January 2007. Promoted

trade liberalization, decreased the poverty rate, and created jobs for large numbers of workers. Industry's share increased from 36% to 41% in the period 2000 to 2010 (CIA, 2013). These contributed to an average annual growth rate of 7.4% per year between 1990 and 2008, coupled with a dramatic reduction in poverty from 58% to 14.5% between 1993 and 2008, based on the national poverty line and a fall in the proportion of people living under a dollar a day from 63% to 21.5% between 1993 and 2006. In 2008, there are recorded GDP per capita of \$ 1.047 (IMF 2008; WB 2008).

Agriculture's share of economic output has continued to shrink from about 25% in 2000 to less than 22% in 2012, while industry's share increased from 36% to nearly 41% in the same period. State-owned enterprises account for roughly 40% of GDP. Poverty has declined significantly, and Vietnam is working to create jobs to meet the challenge of a labor force that is growing by more than one million people every year. The global recession hurt Vietnam's export-oriented economy, with GDP in 2009-12 growing less than the 7% per annum average achieved during the previous decade (see Fig. 3) (CIA, 2013).

**Figure 3:** The growth rate of GDP



Source: Tradingeconomics, 2013.

In 2012, however, exports increased by more than 12%, year-on-year; several administrative actions brought the trade deficit back into balance. Between 2008 and 2011, Vietnam's managed currency, the dong, was devalued in excess of 20%, but its

value remained stable in 2012. Foreign direct investment inflows fell 4.5% to \$10.5 billion in 2012. Foreign donors have pledged \$6.5 billion in new development assistance for 2013. Hanoi has oscillated between promoting growth and emphasizing macroeconomic stability in recent years. In February 2011, the Government shifted policy away from policies aimed at achieving a high rate of economic growth, which had stoked inflation, to those aimed at stabilizing the economy, through tighter monetary and fiscal control. In early 2012 Vietnam unveiled a broad, "three pillar" economic reform program, proposing the restructuring of public investment, state-owned enterprises, and the banking sector. Vietnam's economy continues to face challenges from an undercapitalized banking sector. Non-performing loans weigh heavily on banks and businesses. In September 2012, the official bad debt ratio climbed to 8.8%, though some financial analysts believe it could be as high as 15% (CIA, 2013).

Vietnam's economy is constantly evolving at high speed after two decades of innovation. Currently, Vietnam has emerged from the group of low-income countries with living standards improving, the poverty rate declined, the democracy got enhanced, so national defense and internal security got firmly consolidated. Vietnam step by step surpassed many difficulties, hindrances, and achieved great results. Economy is moving in the direction of industrialization and modernization.

#### **2.1.4 Agriculture**

The particular domestication processes of plants and animals and the habits of farming, utilizing products of different ethnicities are the important cause of the abundance in agro-forestry biodiversity. Remarkable to notice is also the diverse ethnobotanical knowledge. Vietnam is acknowledged as a country of early-developed agricultural civilization, which is another cause for the agro-forestry diversity (MARD, 2009).

In Vietnam, with 90 % of the poor, or three quarters of the population, live in the rural areas, for that reason rural development and agriculture are critical to Vietnam (WB, 2007).



Agriculture has a very important role in Vietnam's economy, contributed 22.1% of GDP in 2008, nearly 30% of exports and over 60% of labor force Vietnam's agriculture has a high and sustained growth during the term, achieve great accomplishments. Export turnover in 2008 reached about 16 billion dollars more than 3.8 times in 2000, in which the average growth of exports from 2000 to 2008 are: rice 13.6%, coffee 19.4%, rubber 32.5%, cashew nuts 27.8%, 19.1% of seafood (MARD, 2009).

Market orientations in agricultural production have become increasingly significant. Peasant households became autonomous economic units in Vietnam. The system of state enterprises has been reorganized. The incomes of farmers and rural infrastructure have been improved. Many issues needed in agriculture, and rural farmers are creating pressure for economic growth and socio-economic stability. In the context of trade liberalization and globalization, in a densely populated country, the average land area per capita is low.

Agriculture employs about 65% of the national labor force and 72% in the private sector. Crop cultivation accounted for nearly 78% of the gross value of agricultural production, the balance of 22% coming from livestock production and service activities (Nguyen Van, 2002).

Food production is the most important sectors of Vietnam's agriculture. Rice is the staple food of the country and it is important food crop, accounting for the largest planted area. It is grown on about four-fifths of the cropped land, principally in the Red River and Mekong River deltas. Other major food crops are corn (maize), cassava (manioc), sweet potatoes and also soybeans, peanuts (groundnuts) (see Table 1) (Nguyen Van, 2002).

Vietnam has achieved high growth in agriculture, especially in the field of food production. Food production is important not only for the needs of people in the country but also in large quantities for export. The average food per person increased from 445 kg in 2000 to 501 kg in 2008, Vietnam ensure adequate domestic food and export of more than 4 million tons of rice per year (Nguyen Thanh and Baldeo Singh, 2006). Vietnam has moved well beyond earlier experiences of chronic food shortages to being the world's second largest rice exporter after a long period of food shortage. Vietnam

has become the exporter of products from cassava (cassava starch and cassava chips) as well.

**Table 1:** Area, yield and production of main crops of Vietnam

<b>Crop</b>	<b>Targets</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2010</b>
Rice	Area (1000 ha)	6,766	7,666	7,326	7,324
	Yield (tons/ha)	3,68	4,24	4,88	4,89
	Production (mill. tons)	24,96	32,52	35,79	35,82
Maize	Area (mill. ha)	556	730	995	1,031
	Yield (tons/ha)	2,11	2,74	3,51	3,7
	Production (mill. tons)	1,17	2	3,5	3,82
Cassava	Area (thousand ha)	277	237	432	475
	Yield (tons/ha)	7,97	8,35	15,35	16,24
	Production (mill. tons)	2,21	1,98	6,64	7,71
Sweet Potato	Area (thousand ha)	304	254	205	181
	Yield (tons/ha)	5,53	6,33	7,56	8

Source: FAOSTAT, 2010.

Draft animals (DA) are now playing an increasingly important role in agricultural development with the growing rate at 6.9 % per year. Lowland farmers as well as ethnic minorities in the mountainous areas raise the highest number of domesticated livestock. Draft animals in Vietnam, however, are closely integrating with rice cultivation. Use power animal in systems are still operating in traditional way in the rural areas, and it has a low productivity. The main objectives of use power animals are to satisfy the human demands for meat, milk, traction and fertilizer for cultivation (FAO, 2010).

## **2.2 DRAFT ANIMALS IN VIETNAM**

In Asia, a greater proportion of farmers depend on animals for draught power than in any other parts of the world. In most parts of Asia, draft animal power is buffaloes and cattle are used for draft purposes, although buffaloes are the most important draft animals in South-East Asia, including Vietnam (Bunyavejchewin et al., 1985a; Kehoe and Chu, 1987; Toelihere, 1989; Bouahom, 1995).

### **2.2.1 Animal traction**

Draft animal power has a long history of use in smallholder farming systems in Asia including Vietnam. Large ruminants provide power for land preparation, soil conservation practices and haulage (de Guzman and Petheram, 1993).

Animal traction is the use of animals [cattle (bulls, oxen and cows), donkeys, mules, horses, goats, camels, water buffaloes, etc.], to assist farmers in carrying out the following tasks (FAO, 2010):

- In agriculture: for ploughing, harrowing, planting, ridging, weeding, mowing and harvesting.
- In transport: for pulling cars and loads over a surface, logging and carrying loads (pack animals).
- In irrigation: for driving water-pumps and pulling water from wells
- In the building industry: for assisting in earth moving for road - works, for carrying bricks, etc.
- To provide power for the operation of stationary implements such as threshing machines, grain mills and food processing machines.

In many parts of the animal traction is seen by many farmers and policy makers as an appropriate, affordable and sustainable technology. Works of animals are providing farmers with vital power for crop production and transportation to reduce the drudgery and intensity agricultural production, so raising living standards throughout the communities to benefit men, women, young and old (Simalenga, Joubert, 1997).

### 2.2.2 Working performance of draft animals

Draft animals work an average of 68 and 51 days a year, respectively in the lowland rice and mixed systems like rice-based, maize-based, as well as those in the so-called “hilly lands” (Devendra C et al., 1997). The number of hours that an animal can work in a day depends on several factors, including the climate, rest periods and pattern of working.

The most important criterion for draught effort is body mass (or live weight). This reflects the amount of muscle on a lean animal and, thus, its potential to exert a force or, more specifically, a pull, which the farmer can use through soil-working implements. A basic guide is that a healthy animal can pull about 10 to 15% of its weight for a working period of around four hours, although there is some variation between species, breeds and working conditions (see Table 2).

**Table 2:** Working performance of draught animals

<b>Animal</b>	<b>Average weight (kg)</b>	<b>Approximate draught (kg)</b>	<b>Average speed of work (m/s)</b>	<b>Power developed (kW)</b>	<b>Working hours (h/day)</b>
<b>Bullock</b>	500-900	60-80	0.6-0.85	0.56	5-6
<b>Cow</b>	400-600	50-60	0.7	0.35	2-3
<b>Buffalo</b>	400-900	50-80	0.8-0.9	0.55	5-6
<b>Horse</b>	60-80	60-80	1.0	0.75	6-10
<b>Donkey</b>	30-40	30-40	0.7	0.25	3-4

Source: FAO, 2010

Many factors affect the working performance of draught animals, including climatic environment, terrain, breed characteristics, temperament, physical condition, age, feeding and care, and training and management (Starkey, 1989).

Draught animals do have the important characteristic that they can generate

substantially higher draught forces outputs over a short period. The working performance of a draught animal is a function primarily of its weight, provided. Thus, for example, in parts of Vietnam where it is difficult to provide adequate fodder for animals, the draught force generated by oxen is typically somewhat less than 10%. In Vietnam, buffaloes are generally larger, heavier and stronger than other bovine breeds (Hoffmann et al., 1989).

Using two or more animals harnessed together results in a relative loss in efficiency for each of them, thus: A pair of animals harnessed together will only produce about 1.9 times the tractive effort of a single animal. Two pairs of animals harnessed together will only produce about 3.2 times the tractive effort of a single animal. Three pairs of animals harnessed together will only produce about 3.8 times the tractive effort of a single animal. In practice it is frequently necessary to use more than one animal in order to generate sufficient particular tasks, even total though than tractive effort the tractive harnessing of harnessing of more than two animals to work together is much less common, and makes the harnessing arrangement more complex. As far as possible it is preferable to use a maximum of two animals harnessed together, with the implement matched to their output and to the soil conditions (Starkey, 1989).

“The energy cost of work can be determined by measuring the animal’s metabolic rate whilst working. Farmers will choose which animal fits in with their system of farming from what is available and affordable” (O’Neill, 1999).

### **2.2.3 Environmental physiology**

The ability of DAs is strongly influenced by environmental conditions, especially ambient temperature and solar radiation. There have been few studies in Southeast Asian countries concerning physiological responses of DAs, in terms of body temperatures, respiration rate and heart or pulse rates, as observed under various working conditions (Bunyavejchewin et al. 1985; De Los Santos and Momongan 1988); and in terms of haematological values (De Los Santos and Momongan 1988).

The ability of buffaloes to withstand the environmental conditions prevailing in

the tropics is widely recognized. However, while the buffalo is amazingly versatile, it does indeed have less physiological adaptation to extremes of environment change compared with various breeds of cattle. “The body temperature of buffaloes is actually slightly lower than that of cattle, despite the fact that buffalo skin is usually black and heat-absorbent and only sparsely protected by hair. Moreover, buffaloes have fewer sweat glands than most other bovidae do, which, by poorly dispersing heat by sweating, makes them fairly sensitive to heat” (Pietersen and Ffoulkes, 1988).

If buffaloes were worked or driven excessively in the hot sun, their body temperature, pulse rate, respiratory rate and general distress levels would increase more quickly than those of cattle. Therefore, “buffaloes usually cool down by wallowing in mud, rather than seeking shade. Wallowing in mud helps them to cool their body temperature because water in mud evaporates more slowly than does water on its own, thus extending the effectiveness of cooling when ambient temperatures and humidity are high, as is common in tropical Thailand” (De Los Santos and Momongan, 1988).

In general, while working buffalo showed signs of heat stress more quickly than cattle steers, the rate of decline under the shade appeared similar, except that in wallowing buffalo rates dropped more rapidly (Bakrie et al. 1987).

Shimizu (1988) also reveals that steers of small and large size showed different physiological responses during work. Due to the impact of heat stress on draught buffalo, some cooling techniques were suggested, in order to increase work efficiency.

#### **2.2.4 Role of draft animal power**

Despite efforts to increase the level of mechanization, animals remain an important existing or potential source of power in rural areas of developing countries, including Vietnam, mechanization in agriculture, as are problems associated with the increasing cost and scarcity of petrol and diesel fuel.

Draft animals are very important asset for the poor in developing countries and are highly valued by many communities in rained arid and semi-arid lands and hilly and mountainous areas. Draft animals permit more land to be cultivated in a timely manner

and with less human drudgery. Furthermore, the increasing miniaturization of land holdings in the mixed farming system limits use of expensive farm machineries” (Hlaing, 2001).

For example, there is paucity of documentation on the extent of economic contributions of draft buffaloes in Vietnam economy but the magnitude of contributions are hidden in the value and volume of production of major agricultural crops such as rice, corn, sugar cane, coconut and others.

No denying that livestock has been a part of human history, not only as an important source of food, but also for tillage and transport. While other species of farm animals have been widely commercialized from its traditionally wild and natural habitat in the early centuries, buffalo can be considered a late entrant, commercial-size operation becomes more pronounced only when domesticated breeds have been introduced outside of Asia. The traditional role of buffalo as source for draft and transport still remains dominant in Vietnam, and is almost associated with the smallholder farmers in mixed-farming system (Shanmugavelu and Zahari, 2009).

“The water buffalo is the classic work animal of Vietnam, an integral part of that continent's traditional village farming structure. Probably the most adaptable and versatile of all work animals, it is widely used to plow; level land; plant crops; puddle rice fields; cultivate field crops; pump water; haul carts, sleds, and shallow-draft boats; carry people; thresh grain; press sugar cane; haul logs; and much more” (Bostid, 1981).

## 2.3 WATER BUFFALO IN VIETNAM

About 98% of buffalo in Vietnam are raised by small farmers owning less than two hectares of land and less than five buffalo. The buffalo originated in the Indo-Gangetic Plain, thrived throughout Asia and became a symbol of life, religion and endurance (Bunyavejchewin et al., 1994; Khan, 2001).

### 2.3.1 The main types of water buffalo

In Asian, water buffalo are of two distinct types:

- The riverine type that populate the Indian continent, to include India, Pakistan, Bangladesh, Sri Lanka and Nepal.
- The swamp type that populate the SEA countries like Vietnam, China, Thailand, the Philippines, Laos, Cambodia, Indonesia, Malaysia and Myanmar (Khan, 2001).

In Vietnam, buffalo mainly known as swamp type (*Bubalus bubalis*) is traditionally raised for multipurpose in agriculture production (Do Kim and Nguyen V. L., 2001)

The swamp buffaloes are usually dark grey but may also be black (see annex, Figure I, Figure II, Figure III), black and white, or even all white. The body size of swamp buffalo in Vietnam is not as big as river type buffalo, but it is two times bigger than the size of the local yellow cattle. “They are found from the Philippines to as far west as India. They wallow in any water or mud puddle they can find or make. Primarily employed as a work animal, the swamp buffalo is also used for meat but almost never for milk production” (Do Kim and Nguyen V. L., 2001).

There are many recognized distinct breeds of buffaloes in Vietnam; some are more common while many are less known and are destined to get lost in the future in the absence of organized and deliberate efforts to save these breeds (Ahlawat et al., 2006; Del Barrio, 2009; Pak-Uthai, 2009). “It is assumed that two breeds of swamp buffalo are raised: a big one and a small one” (Hoang, 1978; Nguyen Duc, 1979; Nguyen Van, 1987).



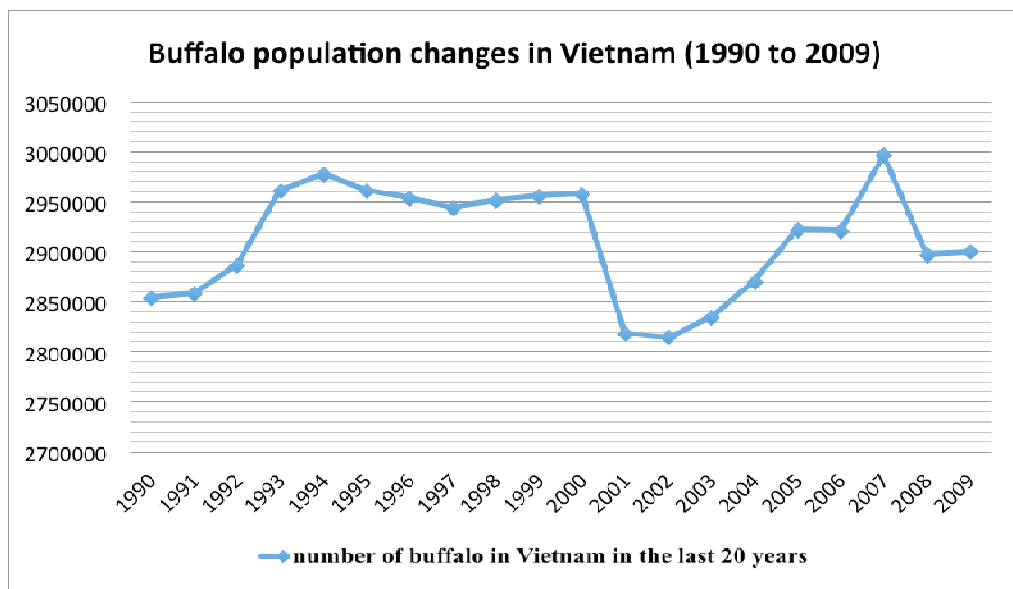
### 2.3.2 The population and distribution of water buffalo

In Asian, buffaloes dominate the world population, representing 96.4% of the worldwide population of 180.7 million as of 2008. Within the Asian region, about 74.8% of buffaloes are in the South, 12.8% in East Asia, and only 8.4% are found in South-East Asia (FAO, 2010). Buffalo population in major Asian countries is presented in the Table I (annex).

Although buffalo population in the world is increasing about 1.3% annually, but the rate of increase of swamp buffalo in Vietnam is low (0.73%). At present, buffalo population of Vietnam is about 2.9 million heads and for example cattle population is 4.2 million (Do Kim, 2009).

There was a reduction in the population of swamp buffalo from 2001 to 2003 compare to 1990 due to a decrease in the grazing land as a result of an increase in the area under cultivation (see Fig. 4) (Shanmugavelu and Zahari, 2009; State Statistic Department, 2010).

**Figure 4:** Buffalo population changes in Vietnam (1990 to 2009)



Source: State Statistic Department, 2010. \*Estimated number.

This situation was happened in the lowland, particular in the Mekong and Red

river delta provinces where the buffaloes are grazed extensively. However, there has been an increase in number in areas, where grazing lands are still available, so the increasing rate buffalo population of Vietnam in last 20 years was very low (0.73) when compare with cattle population (2.8%) (Do Kim, 2009).

It seems also difficult to stop the reduction of buffaloes population in the provinces where mechanization has already occurred and is well implemented, especially in the lowlands of Mekong and the Red river delta provinces (Ly, 2001).

Swamp buffalo is distributed in all parts of Vietnam but it's more concentrated in the Northern Mountain Upland part because the ecological conditions of this region are suitable for buffalo production (see Fig. 5) (Do Kim, 2009).

**Figure 5:** Distribution of buffalo population in Vietnam, by Province (thousand heads)



Source: Thuy Le et al., 2010.

“More than 52% of buffalo population is distributed in the Northern Mountain Upland, where the buffaloes are more valuable to the smallholder farmers not only for farm work and transportation of farm products but also for economic income of the farmers” (Do Kim, 2009).

### 2.3.3 Working performance and common physiological parameters

More than 74% of female buffaloes produced at least two calves every three years and the total yield per female buffalo attained 9 - 10 calves. Mature buffaloes had an average dressed carcass weight of 276 kg, a dressing percentage of 47% (Nguyen Van, 2000).

Buffalo’s body size varied according to the conditions of the soil, water and vegetation in each area of the delta. “Buffaloes in the Mekong Delta are larger than in other regions, and those in Dong Thap province were found to be the biggest in Vietnam, with average live weights of 558 kg for females and 494 kg for males (see Table 3). Average rate of gain from birth to three years of age was about 300 g/day for swamp buffaloes under village feeding conditions” (Nguyen Van, 2000).

**Table 3:** Basic measurements and live weight of adult swamp buffaloes in the Mekong delta of Vietnam

<b>Parameter</b>	<b>Female</b>	<b>Male</b>
Height at withers (cm)	127	130
Length of body (cm)	140	143
Live weight (kg)	558	494

From 7-10 years old.

Source: Nguyen Van, 2000

This observation was similar to that observed by Mason (1974), the live weights of adult buffaloes in fresh water regions were higher than the weights of those living in brackish regions. Farmers in the Mekong delta have a long tradition of raising buffaloes

and are very experienced, but techniques are mostly primitive.

Feeds for buffaloes are limited in the brackish areas and malnutrition of working buffaloes often occurs at the end of the dry season and at the beginning of the rainy season when animals have to do the most work. This causes poor health, and buffaloes sometimes have to be sold or slaughtered (Nguyen Van and Nguyen Van, 1993).

By Nguyen V. T (2000): “In the soil conditions of the Mekong delta, the buffalo can plough from 0.2 to 0.4 ha/pair/day with a working time of just over 5 hours/day”. Both male and female buffalo are used for work in the fields with a working time of 5.05 to 5.39 hours/day, ploughed areas is 0.31 and 0.29 ha/pair/day, while harrowed areas is 0.77 and 0.73 ha/pair/day for males and females respectively (see Table 4). Swamp buffaloes in the north of Vietnam were reported by Nguyen Duc (1979) to plough 0.12 - 0.13 ha/animal/day.

**Table 4:** Ploughing and harrowing performance of swamp buffaloes in Long My district, Can Tho province of Mekong delta, Vietnam

Criteria	Ploughing		Harrowing	
	Female	Male	Female	Male
Working time (hrs./day)	5.35	5.39	5.05	5.28
Ploughed area (ha/pair/day)	0.29	0.31	0.73	0.77
Speed (m/min)	53.0	57.9	58.5	58.8
Recovery time (min)	15.1	14.7	14.3	14.3

Source : Nguyen Van, 2000.

From the Table 4 is evident that the time required by buffaloes to recover from work by wallowing is from 14.3-15.1 min for both male and female. Their resting body temperature, pulse and respiration rate were all slightly higher in the afternoon compared to in the morning before working. After working the body temperature, pulse and respiration rate were all considerably higher than before work. “Values recorded after work was 40.1- 40.7°C, 67.7 – 71.1 beats/min and 86.8 – 96.9 breaths/min for males and females respectively” (Nguyen Van, 2000; Nguyen Van 2000a). Although

the work performance of female buffaloes was lower than that of males when ploughing, performance was similar when doing the lighter work of harrowing. Similarly, when the work was heavy, pulse and respiration rates of females were clearly higher than those of males but there was little difference when the animals were harrowing. Body temperature increased (over 40°C) and was similar for both male and female regardless of whether they had been ploughing or harrowing.

#### **2.3.4 Feeding and management**

In Vietnam, farmers have a long tradition and a lot of experience of buffalo raising but techniques are mostly primitive. Management practices are based on extensive systems and buffaloes are freely grazed on natural grasses land, forests, roadsides, canal banks, rice field after harvesting and dikes, etc. They are also fed with rice straw or other crop residues in the dry season and working season. Farmers normally do not fatten buffaloes before sell for meat but middle man occasionally by and fatten them by good quality grass and some concentrate before sale. Buffaloes are mainly slaughtered when they are not able to work due to old age or as a result of accidents. Housing for buffaloes is simple and often made by local materials such as wood or bamboo with a palm leaves roof in the mountain area, but in the plain area the housing for buffalo is better with concrete floor and brick wall and tile roof (Nguyen Van et al., 1995).

Swamp buffalo can utilize waste and crops by products as straw and grasses, which cannot utilize by human. It can serve as long-term capital reserve by using local natural resource as long as fodder resources are freely accessible at no charge (Do Kim, 2009).

### **2.3.5 Buffalo meat and milk production**

Undoubtedly, majority of world's buffalo meat is Asian, representing 91.89% and with volume of 3.1 million tons in 2008 (FAO, 2010). Vietnam produces about 2.3% of the total Asian buffaloes meat (Do Kim, 2009; State Statistics Department, 2009).

In Vietnam the cattle population is twice higher comparing to buffalo, however, the buffalo body size is larger than cattle so annually, total buffalo meat production is always contributed more than 50% of total ruminant meat production of the country (Do Kim, 2009). Generally, in developing countries of Asia where meat from ruminants constitute only about 21.0% of the total meat production, buffalo meat is about 11.52% of the total ruminant meat, and about 2.7% of all meat produced in the region. The average annual growth rate in production in Asia is about 1.3% (FAO, 2010) and in Vietnam is approximately 4.78% for the last 7 years (see Table 5) (Do Kim, 2009; State Statistics Department, 2009).

About 78.5% of Asian buffalo meat is produced in South and South West Asia with the greater bulk contributed by India and followed by Pakistan. These two countries have 75% of the buffalo population in the region. Improvement in buffalo meat yield is contributed by the increasing usage of male calves, which were not fully utilized. In the past in the greater part of India, farmers were not paying enough attention to rescue the young animals from high mortality before reaching 6 months of age. In recent years, however, the rising export of Indian buffalo meat have given enough incentives for small herd farmers to rear these animals and put additional weight prior to slaughter, thereby sustaining the growth in the meat harvest from the Indian buffalo sector (FAO, 2010). In comparison, Vietnamese farmers have not yet considered raising buffaloes specifically for meat, much buffalo beef is produced from farmer's households from animals that are not required for draught work (Nguyen Van, 2000).

The development of buffalo meat production in Vietnam is presented in the Table 5.

**Table 5:** Buffalo meat production in Vietnam (2001-2008)

	2001	2002	2003	2004	2005	2006	2007	2008
<b>Meat yield (1000 tones)</b>	51.3	51.8	53.1	57.5	59.8	64.3	67.5	71.1
<b>Increase rate (%)</b>		0.84	2.41	8.29	4.08	7.55	4.95	5.33

Source: Do Kim, 2009; State Statistics Department, 2009.

The 2010 buffalo milk production in Asia represents 96.8 % of the total volumes of world's buffalo milk of 89.2 million tons. Production in South and South West Asia primarily from India and Pakistan contributed a hefty 93.17% (FAO, 2010). Buffaloes are significant sources of milk in this sub-region contributing as high as 68.35% of the total milk yield in Pakistan, and 56.85% in total milk production in India.

Among the SEA countries, Myanmar registered the highest buffalo milk production, apparently because it has one of the highest populations of dairy buffalo (Hlaing, 2001; FAO, 2010). Buffalo milk production from the other SEA countries, including Vietnam, are coming mainly from smaller population of introduced riverine buffaloes and the resulting crossbreds of the dairy breed with the existing swamp buffalo population. In this sub region where farmers tend their animals primarily for work, only a small percentage of crossbreds produced are fully utilized for milk production. Although average annual grow rate of buffalo milk production in Vietnam increase every year, but sill buffalo milk production is not common and very low here (see Table 6).

**Table 6:** Buffalo milk production in Vietnam

<b>Parameter</b>	<b>Swamp</b>	<b>(In the South) Swamp</b>	<b>(In the North) Murrah</b>	<b>F1 crossbred</b>
<b>Lactation period (days)</b>	-	210-360	236	292
<b>Milk yield (kg/day)</b>	1.50	1.20-3.45	5.55	3.5

Source: Nguyen Van, 2000b

Buffalo could be important to milk and meat production of high quality for protein value, for fat with reduced cholesterol and higher unsaturated fatty acids and, finally, for luxurious taste of cheese and meat products. The compositions of buffalo's meat and milk are presented in the Table 7 and Table 8, respectively.

**Table 7:** Composition of buffalo meat

<b>Components</b>	<b>Buffalo meat</b>
<b>Water (%)</b>	74 - 78
<b>Protein (%)</b>	20.2 - 24.1
<b>Fat (%)</b>	0.9 - 1.8
<b>Ash (%)</b>	1.0
<b>Cholesterol (mg %)</b>	61
<b>Energy (Kcal/100g)</b>	131

Source: Nguyen Van, 2000b.

**Table 8:** Composition of buffalo milk, comparison with milk of cows and goats (in 1 liter of milk)

<b>Components</b>	<b>Buffalo</b>	<b>Goat</b>	<b>Cow</b>
<b>Water (g)</b>	825	866	877
<b>Protein (%)</b>	4.7	3.7	3.4
<b>Fat (%)</b>	8.5	3.9	3.9
<b>Cholesterol (mg)</b>	80	110	120
<b>Calcium (mg)</b>	1950	1270	1200
<b>Zinc (mikrg)</b>	6000	2600	3800
<b>Vitamin C (mg)</b>	25	20	17
<b>Energy (kJ)</b>	4700	2810	2690

Source: Shaker, 2010.



It can be summarized that buffalo can transform non-edible human food (crop residues like wheat straw, paddy straw, maize and millet stovers, supplemented with concentrates made out of agricultural by-products such as, oil cakes, rice polish, molasses, etc.) into high quality food for human consumption. Increased buffalo production may add to food security: the poor farmer access to more food with low cost and increase local products with reduce import and save foreign currency (Do Kim, 2009).

### **2.3.6 Role of buffalo in farm and potential in agricultural economics**

Traditionally, buffaloes were raised by small farm holders for multipurpose in agriculture production. However, swamp buffaloes are well suited to poor feeding management as well as adapted to the hot-humid tropical climate conditions (Do Kim, 2009). Buffalo production is traditionally very important in rice culture and meat production as well as being a capital resource of farmers (Ly, 2001). In Vietnam, swamp buffaloes are main source of draught power in agriculture and crops cultivation. The large feet slow steady movement and heavy draught capacity of the swamp buffaloes make them particularly well suited for paddy cultivation in swampy, waterlogged rice-fields. Buffalo is also considered a friend of farmer family not only for draught power and fertilizer but also for take full advantage of feeds resources, free time and subsidiary labors etc. of small farm holder in rural area. Accompanied by various social, cultural and economic conditions, which make the use of buffalo for draught a very appropriate and profitable farming technique (Do Kim, 2009).

For many small farmers the buffalo represents capital. It is often the major investment they have. Buffalo energy increases their productivity and allows them to diversify. Even small farms have work animals that, like the farmer himself, subsist off the farm. Buffaloes are also used for hauling. Buffalo-drawn carts carry goods between villages where road surfaces are unfit for trucks. The animals easily traverse ravines, streams, paddies, and narrow and rocky trails. In the cities carts can compete economically with trucks where the road surface is unprepared, where loading or unloading takes longer than the journey itself, or where the loads are too small and

distances too short to make trucking economical. For road haulage buffaloes are generally shod: the shoes are flat plates fitted to each hoof (Bostid, 1981).

The Ha Giang province bordering China is one of the poorest Vietnamese provinces where agriculture is the main source of income for householders. It is characterized by a temperate climate and mountainous landscape. As a consequence, mechanization or intensification of farming systems has been more difficult to implement than in plain areas. Therefore, “the buffalo, used as draught power, plays a key role in the sustainability of agriculture. Management (characterization, conservation and improvement) of the swamp buffalo may be a sustainable way to improve farming systems and alleviate poverty in such mountainous areas (Hoang, 1978; Nguyen Duc, 1979; Nguyen Van, 1987).

Duc (1998) made a comparison of total life time expenses, income and net profit for a pair of buffaloes (one male and one female) and for a four wheel tractor MTZ, and the economic efficiency of a pair of buffalo was 2.6 times that of a tractor. According to Thu et al. (1995) buffaloes are 5.97 and 5.23 times more efficient comparing to tractor in Binh Duong and Tay Ninh provinces of the Southeastern region. The results of several studies done in Vietnam have also shown that when the cultivated land area is less than 3 hectares, the economic returns from using draught animals are higher than those from tractors (Dang Tran, 2001).

In Vietnam with the foreseeable future, water buffalo will continue to play a significant role as a source of animal power to small farm systems. Water buffaloes will therefore continue to serve as multipurpose animals with some transition from draft buffalo to a small tractor or a hand tractor where crop production depends on rainfall.

### **3. AIM OF THE THESIS**

The purpose of this thesis is to analyze the role and the characteristics of buffalo as the main draft animal used in Vietnamese agriculture; explain advantages and disadvantages of its usage.

The other objective is to consider the difference of traditional use of draft animals and mechanization in agricultural of Vietnam through agricultural engineering purposes.

Specific objectives of the present thesis are following:

- Socio - economic importance of the buffalo in Vietnam
- Environmental consequences

## 4. METHODOLOGY

The construction method of this thesis was made in three steps:

1. The first step is gathering of documents and information about general characteristics of Vietnam and its agriculture;
2. The second step is collection of information about use and exploitation of animal power mainly buffalo;
3. The third step is summarization and analysis of information and elaboration of the present thesis.

The main purpose of this work is to investigate the scientific literature based on the following criteria:

- The main part of the thesis gives an overview of working animals (with the special focus on buffalo) in Vietnamese Agriculture. The following key words were used: buffalo, agriculture, animal power, Vietnam.
- Then, for the basic overview of working animals in Vietnamese Agriculture, the literature from the web pages of International Organization such as the World Bank, Asian Development Bank and the CIA World, FAO, Fact Book, etc. was mainly used. For the analysis of the actual situation in Vietnamese Agricultural, information from the professional scientific journals, the Internet pages of Science Direct and Web Knowledge of relevant articles was collected.
- In addition, own experiences from living in Vietnam, documents obtained from the Ministry of Agriculture and Rural Development in Vietnam, as well as statistics and information from the Vietnam Development Information Centre in Hanoi and from General Statistics Office of Vietnam were used.
- The articles used were carefully selected in accordance to date with 1978 being the latest. The sources of information have been subjected to evaluation and analysis with more details in the conclusion section.

## 5. RESULTS AND DISCUSSION

Animal traction is an appropriate and sustainable technology, which is increasingly being used in Vietnam. The benefits of animal traction are:

The animal power is renewable energy source in accordance with households in the agricultural sector and rural transportation. The animal traction provide affordable and easy to use for farmers. It has an important role in food production to provide consumers. Power availability of animal helps human to reduce the difficulties in work, so they can save time and power, and increase crop yields. Animal transport is important in the implementation of agricultural inputs (seeds, fertilizers, plan...). Animal work, contribute to food production through fertilizer, milk, meat... and facilitate the marketing of products, promote trade and the local production development.

In the areas, animal power can be done with the short time and better than human power. Animals can carry the heavy works that humans cannot perform. For example, transportation of large quantities of water to irrigate crops, transport of fuel and reduce the heavy workload of women. Animal power requires a low cost investment plan while investing of the engine and machinery are very high. The investment for animal power in rural areas helps promote and revitalizes rural economies. While power from machinery also provides more benefits, the animal power is available with reasonable prices for people in rural areas. That reduces environmental pollution.

Animal power uses for some special working as plowing, sowing and harvesting for in the large areas and record time compared with human. Animal power provides farmers with vital power for cultivation and transport, use of draft animals giving people an alternative energy. Providing employment, transportation, promoting food production and security thus makes the living standard for people higher. Helping women to reduce the burden of transporting water by the head, hands, wheelbarrows, use of animals in harvest and exchange of goods more easily.

Buffalo in Asia will still be a small holder animal in the foreseeable future, playing an important role in the lives of small holder resource-poor farming families in the developing countries in Asia. Harnessing the full potential of this Asian animal will

benefit the majority of the rural farming families and at the same time meet the requirements of the fast-growing Asian economy through organized groups and cooperatives to promote entrepreneurship.

Especially in Vietnam's agriculture, rice is the traditional crop and it is very important. In the cultivation of rice, farmers have used the buffalo as a traditional method of rice culture. Buffalo is the main animal used in agriculture by its ability to soak in water and adjusting to the environment. With weight 400-900 kg, it creates energy consistent with the work. Currently, donkeys are used in small farms in Vietnam compared with lower energy buffalo at 0.25 kW and it is suitable for the preparation of land and cultivation. Weight of the horse is not equal to weight of the buffalo, the cow and therefore can not generate more energy at work, they fit with the works that required low-power and average speed of horse is 10-12 km/h, are suitable for transporting goods to market.

Undoubtedly the emergence of semi-commercial buffalo-based dairying as models for future growth in many potential areas is encouraging. In recent years, swamp buffaloes as commercial intensively irrigated areas of Mekong delta have reduced its role as source of draft and are being replaced slowly by farm machineries. In order that the existing huge animal resource can be of benefit to the rural farming families, transformation of these animals to become efficient producers of milk and meat by way of crossbreeding with riverine breeds is now being pursued with good degree of success.

In Vietnam, swamp buffaloes are main source of draught power in agriculture and crops cultivation. The large feet slow steady movement and heavy draught capacity of the swamp buffaloes make them particularly well suited for paddy cultivation in swampy, waterlogged rice-fields. Accompanied by various social, cultural and economical conditions, which make the use of buffalo for draught a very appropriate and profitable farming technique (Do Kim, 2009).

Traditionally, buffaloes were raised by small farm holders for multipurpose in agriculture production. However, swamp buffaloes are well suited to poor feeding management as well as adapted to the hot-humid tropical climate conditions. Buffalo raising is closely integrate with paddy rice cultivation and it plays an importance role in total agriculture production of the country. Buffalo is also considered a friend of farmer family not only for draught power and fertilizer but also for take full advantage of feeds

resources, free time and subsidiary labors etc... of small farm holder in rural area (Do Kim, 2009)

For many small farmers the buffalo represents capital. It is often the major investment they have. Buffalo energy increases their productivity and allows them to diversify. Even small farms have work animals that, like the farmer himself, subsist off the farm. Buffaloes are also used for hauling. Buffalo-drawn carts carry goods between villages where road surfaces are unfit for trucks. The animals easily traverse ravines, streams, paddies, and narrow and rocky trails. In the cities carts can compete economically with trucks where the road surface is unprepared, where loading or unloading takes longer than the journey itself, or where the loads are too small and distances too short to make trucking economical. For road haulage buffaloes are generally shod: the shoes are flat plates fitted to each hoof (Bostid, 1981).

Buffalo's strength is utilized for all possible actions in the agricultural production as mentioned above. The main reason that leads farmers to use buffalo is that some stages are not as productive without animal draught strength. Those important stages are the primary and secondary tillage, seeding, harvesting, plowing, transport.

Draught power is not as critical as formerly, and since agricultural mechanization is developed. In some regions the role of buffaloes is sometimes neglected. Even if soil preparation could be mechanized, the buffalo remains important for rural transport and meat. Buffalo meat accounts for half of all beef. Despite this the buffalo herd remains static; numbers fell by 0.43 percent from 1995 to 2000 (General Statistics, 2000) and have remained the same from 2000 to 2004.

Animals can be bought for much less and are readily available, ensuring that the farmer does not have to wait to carry out his various activities and is in full control of his farming operations. They are less of a risk. Owning draught animals on a small farm will usually empower the farmer. Animals are easy to work with and can, in the case of donkeys, be used by women and children.

As countries in the world, swamp buffalo are the most neglected and forgotten animals in Vietnam due to many reasons as following:

More consideration of cattle production compared to buffalo in livestock development plan. There were no extension program and less research budget support

for buffalo production, so buffalo production system had been paid no attention by State management organizations from Central to grass-root levels.

From 1990 to 2002, there is no program and no policy for buffalo development and no extension service concerning to buffalo from DAFE of MARD.

Lacking of grazing land areas by the result of reforestation program and shortage of forest during the winter season affected to the growth rate and low reproductive efficiency of swamp buffalo. Low productivity: low growth rate and especially low calving rate, the reason for this including due to lacking of common grazing area and bulls.

Water buffaloes will therefore continue to serve as multi-purpose animals with some transition from draft buffalo to a small tractor or a hand tractor where crop production depends on rainfall. The small tractor is also fashionable among rural farmers for its fast speed in working, but its cost-effectiveness is questionable.

Animal traction, as well as electricity, education, rural road networks and communications, can empower rural communities. Using draft animals in agriculture makes a huge difference in the region of the developing country. Not only because of the climate characteristics, but also because this has financial implications and traditional methods require a proper use of the working animals.

Despite the years of neglect, animal traction is still a major farm power component by farmers. Until 2010, draft animal production still played an important role in overall agricultural production for small farmers, especially farmers in mountainous terrain. Animal resources provided the main working power, fertilizer, and available food.

The annual growth rate of draft animals is very low but animal traction still offers the best option and opportunities for increase in farm sizes, reducing drudgery in farm work, reducing labour costs, raising yields and farm production in general. For the last years, buffalo population growth rate has been lower than cattle. The buffalo population needs to improve in the coming years by setting up breeding programs for swamp buffalo and focus on good choice for varieties producing high quality buffalo. It is necessary to improve management systems and food for swamp buffalo in small farms. Owners have to meet the production efficiency for higher crop production and better birthrate.



In general with farmers, what they earn in cash is barely sufficient for subsistence. Livestock is generally a means of saving: poultry and pigs are short-term savings while buffalo and cattle are long term ones. The small - holders allied in the cooperative, buffaloes are stronger than cattle and, in the deltas, can be used on both high and low land. Their value is measured in terms of draught power, amount of manure and partly meat.

Buffalo meat accounts for half of all beef. Despite this the buffalo herd remains static; numbers fell by 0.43 percent from 1995 to 2000 (General Statistics, 2000) and have remained the same from 2000 to 2004.

Draught power is not as critical as formerly, and since agricultural mechanization is developed in some regions the role of buffaloes is sometimes neglected. Even if soil preparation could be mechanized, the buffalo remains important for rural transport and meat.

## 6. CONCLUSION

The given results make possible to formulate the following conclusions:

- The rate of use of mechanization in agriculture is increasing; however, animals are used primarily on small farms. More than 50% of the total agriculture areas in Vietnam are still cultivated by draft animals, while only about 30% are cultivated by mechanization. The soil preparation by draft animals positively effects on yield and quality of agricultural crops. There are many ways to use the power of draft animals.
- In Vietnam with the foreseeable future, water buffalo will continue to play a significant role as a source of animal power to small farm systems.
- From socio-economic point of view buffaloes are considered as a long-term investment by farmers and occupy a very high position as a source of inheritance from one generation to the next. They also provide employment, transportation, promoting food production and security thus making the standard of living higher for people
- In some regions the role of buffaloes is sometimes neglected. Even if soil preparation could be mechanized, the buffalo remains important for rural transport and meat.
- An important by-product of the swamp buffalo was manure, which farmers used as fertilizer in plant cultivation. Moreover, small form buffalo production is highly sustainable from biological, social, economic and ecological stand points.
- Use of draft animals giving people an alternative energy. This kind of power is considered to be sustainable with very low impact to environment.
- The buffalo population needs to improve in the coming years by setting up breeding programs for swamp buffalo and focus on good choice for varieties producing high quality buffalo.

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## 8. ANNEX

**Figure I:** Buffalo is ploughing for soil preparation



**Figure II:** Water buffalo is ploughing the terraces



**Figure III:** Image of water buffalo transporting timbers in the forest





**Table I:** Buffalo population in major countries, by Region

<b>Region/Country</b>	<b>Population (heads)</b>	<b>%</b>
<b>East Asia</b>		
China	23,271,909	12.9 %
<b>South East Asia</b>		
Cambodia	746,207	0.4%
Indonesia	2,191,640	1.2%
LPDR	1,155,000	0.6%
Malaysia	131	0.00007%
Myanmar	2,923,568	1.6%
Philippines	3,338,570	1.9%
Thailand	1,699,469	0.9%
Timor-Leste	110	0.00006%
Vietnam	2,897,700	1.6%
<b>South Asia</b>		
Bangladesh	1,262,000	0.7%
India	98,595,000	54.6%
Nepal	4,496,507	2.5%
Pakistan	29,883,000	16.5%
Sri Lanka	31,853	0.02%
<b>World</b>	<b>180,702,923</b>	<b>100%</b>

Source: FAO, 2010.