

Thai beef cattle industry¹

Highlights

- Cattle, mostly South Eastern provinces of Thailand, are widely raised by small holders in mixed cattle-crop systems.
- The predominant breeds are Thai native cattle, and crossbreds including Tak and Kabinburi. The number of commercial feedlots is small (1%).
- The Thai government has implemented a number of important programs to improve breeds and become more self-sufficient and cut beef imports.
- Beef production in Thailand serves for high value, mid value and generic value beef markets.
- Beef production in Thailand has not been able to meet the domestic consumption.
- Thailand is a net exporter of live cattle, and a transit country for cattle movement in the Mekong region.
- Unofficial imports of live cattle from Myanmar, and unofficial exports to Cambodia and Laos have reportedly increased in the past years in response to a growing demand from Vietnam and China.

¹ Luong Pham (HELVETAS), Dominic Smith (UQ/HELVETAS), Monticha putsakum, Warinthorn Maneerat (School of Agriculture and Cooperative) and Witipon Intarathamwarin (DLD) (2015), The Thai Beef Industry in "Regional Workshop on Beef markets and trade in Southeast Asian and China", Ben Tre, Vietnam, 30th November – 3rd December, 2015

1. National industry

1.1. Background

Thailand's population in 2013 was about 67 million people (World Bank, 2014). The country is classified as an upper middle income country by the World Bank with the gross national income per capita of USD 4,210 in 2011 (World Bank, 2011). Thailand's high economic growth of 8-9% per year during the late 1980s and early 1990s was interrupted by the Asian Economic Crisis in 1997-1998 (World Bank, 2014). The GDP growth has since remained at 4.5% at an annual average over the period 2000-2012 (ADB, 2014).

Thailand has been regarded as a development success story, with sustained strong growth and impressive poverty reduction. Poverty in the country fell from 21% in 2000 to around 12.6% in 2012 (UNDP, 2014). However, regional differences remain, with over 80% of the country's 7.3 million poor living in rural areas in 2013 (UNDP, 2014). Some regions—particularly the North and Northeast—and some ethnic groups lag greatly behind others and the benefits of economic success are not shared equally. Income inequality and lack of equal opportunities persist (UNDP, 2014).

Agriculture is still one of the main sources of the national income. The sector currently employs about 39% of Thailand's workforce, and contributes to 11% of GDP (ADB, 2014). As it would be expected in an industrialising economy, the growth of agriculture has been modest at 2.8% annually averaged over the period 2000-2012. Livestock plays an important role in agricultural sector, accounting for 22% of agricultural GDP (Office of Agricultural Economics, 2014). Cattle raising has been identified as 1 of 14 main products in Thai agriculture.

Traditionally, cattle and buffaloes were raised by smallholders for draught purposes, transportation and for manure to be used as fertiliser. However, as mechanisation has replaced draught animals, small farmers have become increasingly specialised in beef production.

Thailand was a net importer of beef cattle up until 2008 as the domestic production had not been able to meet local demand. Thus, the majority of cattle flows were from Laos, Cambodia and Myanmar to Thailand. However, since 2008, the direction of cattle flows has been reversed due to strong demand for beef cattle from China and Vietnam (Bourgeois-Lüthi, 2010). Thailand has become an exporter and a transit country for cattle movement between Myanmar and Vietnam/China.

1.2. Macro production statistics

The statistics² in Table 1 provide an overview of the cattle and beef industry in Thailand. Based on the data from the Office of Agricultural Statistics³, the country had 5.15 million cattle head in 2013 (including draught cattle). Growth in cattle numbers in Thailand is modest (0.8 % per annum).

The slaughter numbers were relatively high compared to other ASEAN countries, at over five hundred thousand head (growing at 3% per annum). The official slaughter levels seem to be lower than the actual slaughtered as the figures may be underestimated. The high turnoff levels are an indication of increased cattle specialisation. The growth in beef supply per capita in Thailand has increased slowly over the period 2000-2013 (1.0%).

² Data is provided by the Office of Agricultural Statistics. Cattle number is reported at the end of each fiscal year. Data on buffaloes and buffalo meat is not included.

³ The Office of Agricultural Statistics is under the Ministry of Agriculture and Cooperatives.

Table 1: Key facts about the industry 2000-2013

		Compounded Annual growth (%)
Herd size (million head 2013):	5.15	0.8%
Turn off/slaughter (million head 2013):	0.53	3.0%
Turn off rate/Slaughter rate (% 2013)	10.2	2.4%
Cattle meat (thousand tonnes 2013) ⁴	160	1.1%
Cattle meat supply (kg/person 2013)	2.39	1.0%

Source: adapted the Office of Agricultural Statistics (2014).

1.3. Macro drivers of the industry change

The cattle industry in Thailand is driven by a number of factors. Firstly, the Thai economy has developed rapidly, thus demand for meat products has increased. Income per capita has grown at a faster rate than other ASEAN countries, and the development of a new urban-based middle class has stimulated a westernisation of tastes and preferences. High income elasticity of demand for beef has influenced in domestic beef production. In addition, these changes have also promoted extensive development in Thailand's international trade in cattle products.

Secondly, private sector innovations such as improved breeds, feed technology, housing, farm management and contractual arrangements have been the prime drivers of growth (Office of Agricultural Economics, 2014). Farm sizes have become significantly large and the expansion is made possible by imported technology and increasing domestic demand.

Thirdly, the cattle industry development has been significantly driven by governmental regulations of slaughterhouses and subsidies (DFAT, 2014). In addition, the export market is a driver for the Thai cattle industry. The demand of cattle and cattle products from Vietnam and China has rapidly increased in the past few years. This includes the demand for high quality feeder cattle for the feedlot industries in these countries. As a result, the prices have increased in these countries, and live cattle have been moved from Thailand through Cambodia and Laos to Vietnam.

1.4. Cattle and beef production

Figure 1 below indicates that the cattle number in Thailand increased from 4.6 million head in 2000 to 6.7 million head in 2007. This was due to the Thai government's policy such as Beef Cattle Farm promotion in the north-eastern region and the One-Million Beef Cattle Households to support farmers to raise beef cattle in an effort to reduce the amount of imported beef (Charoensook et al., 2013). In addition, farmers have replaced traditional buffaloes by cattle (FAO, 2005). This trend reflects the reduced use of draught power, the greater suitability of cattle on newly cleared areas, and the greater productivity of cattle in beef production.

However, the number of cattle dropped from 6.7 million head in 2007 to 5.1 million head in 2013 (Figure 1). Some obvious reasons are the increased mechanisation of agriculture during this period, lack of grazing areas, lack of labour, and strong demand for live cattle from China and Vietnam (Skunmun et al., 2001, Cocks et al., 2009).

Similarly, as shown in Figure 1, the number of cattle slaughtered annually increased from around 335,923 head in 2000 to 620,278 head in 2008, and then reduced to 525,575 head in 2013.

Beef production increased slowly from about 130 thousand tonnes in 2000 to about 160 thousand tonnes in 2013 (Figure 1).

⁴ The cattle meat production figures were calculated from reports on number of cattle slaughtered. Average carcass weight is 144 kg/head.

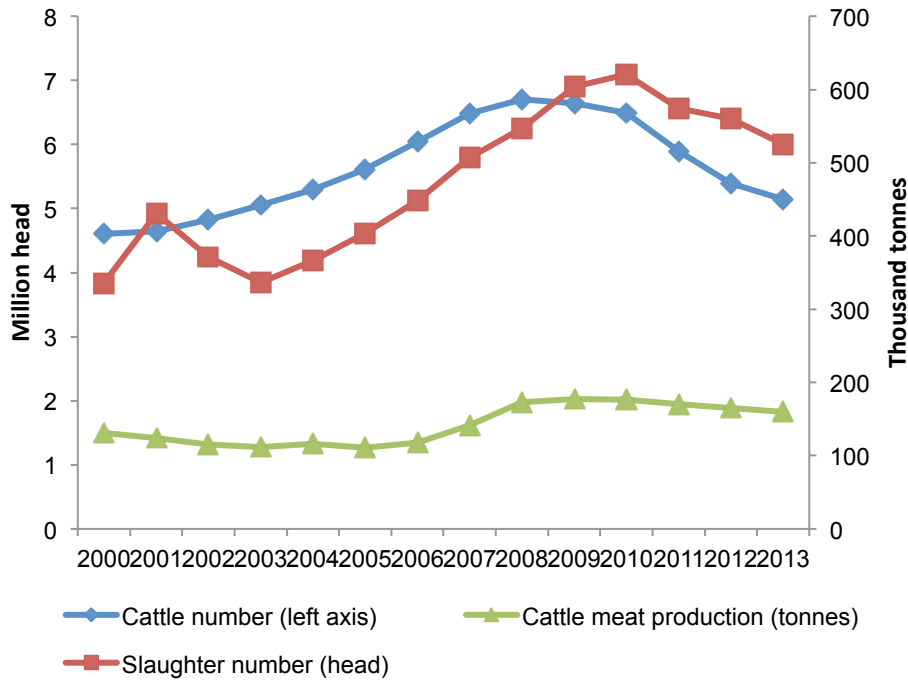


Figure 1: Cattle production in Thailand

Source: DLD (2014)

2. Regional distribution

Thailand is divided into four main agro-ecological zones (Figure 2). Accordingly, the cattle industry is disaggregated into four zones by the Department of Livestock Development. The regional distribution patterns are presented in Figure 3. The changes in beef cattle numbers across the regions were almost the same as for cattle overall in the country.

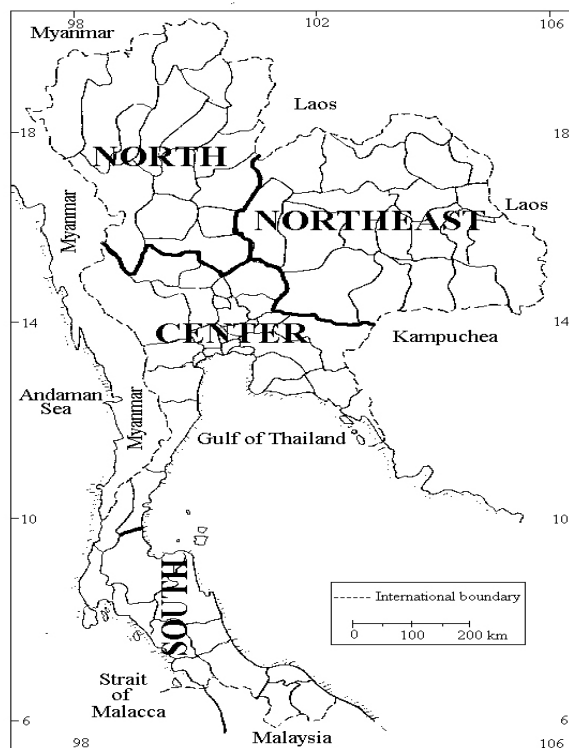


Figure 2: Four main ecological-zones of Thailand.

Source: <http://www.mobot.org/MOBOT/moss/Thailand/geo.shtml>

Cattle are distributed throughout the country, with the highest concentration in the north-eastern region (accounted for around 40%), and the lowest concentration in the southern region (accounted for around 12%) (Figure 3). The southern region is dominated by the plantation of agriculture including rubber, oil palm, fruit trees and coconuts (Phommexay et al., 2011). Therefore, even though it is close to potential markets and faces less of a disease problem than other parts of the country, the cattle number is lowest.

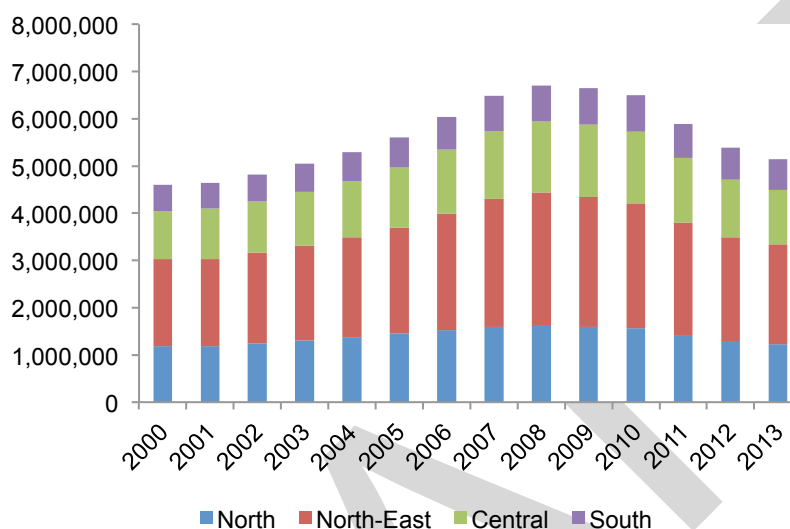


Figure 3: Beef cattle number by regions

Source: DLD (2014)

3. Policy

The Thai government has a strong desire to increase livestock production in order to fulfil demand for domestic consumption as well as exports. In order to encourage farmers to raise cattle for beef, the Thai government has implemented several important programs including the Royal-initiated Cattle and Buffalo Bank project in 1978, the Beef Cattle Farm promotion in the North-eastern region in 1989 and the One-Million Beef Cattle Households promotion in 2004 (Charoensook et al., 2013). For example services provided by the Department of Livestock Development include providing to small-scale farmers through the 'Cattle and Buffalo Bank under the King Initiative' free artificial insemination (AI) services and other beef cattle extension programs.

According to the review by FAO (2005), the following strategies were introduced for the cattle industries by the Thai government in the period 1998 -2001. First, the government continued to sponsor research programs to breed the most suitable animals to produce Brahman parent stock and to distribute them to beef cattle improvement centres for sale to farmers. Second, common grazing areas were set up from available public land. Third, vaccines and disease treatments were made available to farmers to control foot and mouth disease and parasitic infestation. Fourth, farmers were divided into two production groups, with one concentrating on breeding and the other on fattening. To assist in this, the government gave long term credit to farmers. Finally, the government attempted to control the smuggling of cattle as a way of improving the beef price. The government's program proved to be effective as the number of cattle increased in the period 2001-2007.

Thailand applies high tariffs to imports competing with locally produced products, including beef, pork and poultry. However, under the Thailand-Australia free trade agreement, tariffs for on imported beef products will reduce to zero by 2020 (DFAT, 2014).

4. Cattle marketing and trade systems

Live cattle marketing and trade systems for Thailand are presented in Figure 4. Traditional mixed cattle-crop producers often produce cattle for low beef value markets. Cattle marketing chains are characterised by a large number of agents which ensures a competitive price structure at the lower end of the market. Traditional producers often sell their cattle to collectors/ middlemen at farm gate through spot transactions and immediate payment. Some also take their cattle directly to the local cattle market.

At the market, sellers are usually individual farmers, professional traders or opportunistic speculators. Buyers are mainly traders serving slaughter for butchers or slaughter houses (50%). Some buyers purchase for breeding stock or fattening. Bargaining between a seller and a buyer starts when the seller provides information about the price and age of animals. Negotiations for whole truck load occur with well-known buyers/traders. Sellers pay a market fee and obtain the animal health certificate from local livestock officer to pass to the buyer with the cattle. If the buyer wants to move the animals across provinces, they need to get a movement permit and pays a certain fee.

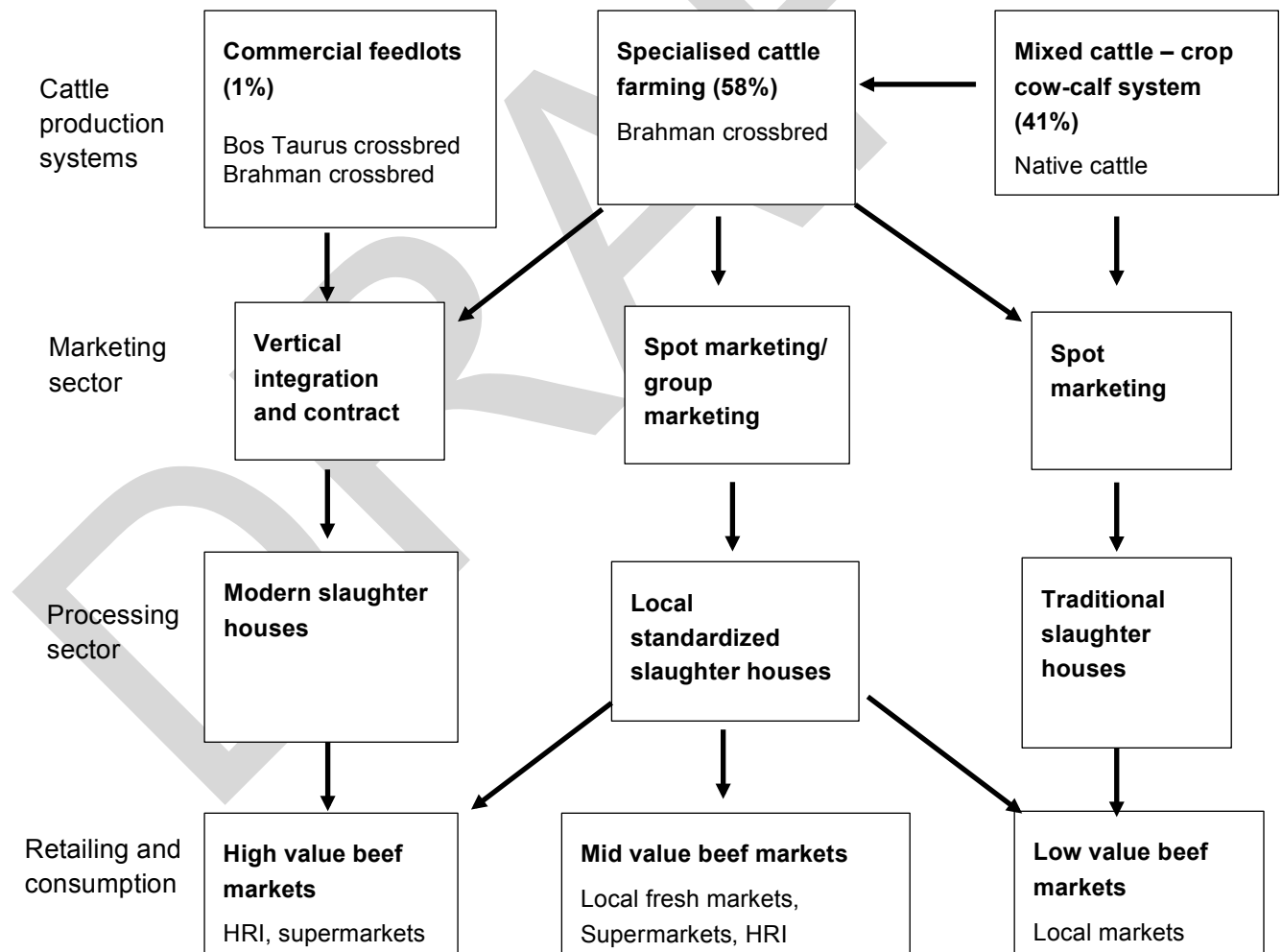


Figure 4: Cattle marketing and trade systems in Thailand.

Source: Skunmun (2014)

Mid and high value cattle producers differentiate their products to be traded. Specialised fattening producers often sell their products through spot marketing or group marketing, while contracting is often done between modern slaughter houses and large commercial feedlots. These producers tend to be located close to destination markets, and often sell directly to butchers or slaughter houses.

5. Inputs sector

5.1. Feed

Thailand has 51.3 million ha land of which 41% is under cultivation of various crops, and 78% of the agricultural area is rainfed (Office of Agricultural Statistics, 2014). Most mixed cattle-crop producers utilised communal land for cattle grazing. Total area of communal land in the country is 369,218 ha.

For native cattle in the mixed cattle-crop systems in the Northern, North-eastern and Central regions, natural grass and crop residues based feeding systems are used. Cattle graze all year round on the roadsides or paddy land or upland crop field before or after harvesting season. Crop residues and by-products including rice and maize straws, rice stubble and cassava chips, are also used as sources of roughage to feed cattle. When the cropping season begins during the rainy season, most of the land is used for rice and crop plantations. The cattle are often fed with rice straw with little extra concentrate or mineral supplements. For beef cattle in these regions, cattle are provided with cut and carry pasture or grazed on improved pasture and supplementary of crop by-product and/or compound feed.

In the Southern region of Thailand, cattle graze under plantations such as rubber, palm oil, orchard or roadsides. Cattle are supplemented with cut and carry fodder grass, fodder tree leaves, palm kernel and palm frond.

For commercial/intensive fattening systems, intensive confine feedlot feeding systems are used. Cattle are fed on compound concentrate feed with minimum quantity of roughage fibre in a ratio of 70:30.

5.2. Breeds and breed improvement

In traditional mixed cattle-crop systems, the most common breed is Thai native cattle (*Bos indicus* type), in the north-eastern region, that are small and have ability to adapt to low quality roughage, and remain productive under stressful environments (Charoensook et al., 2013). Exotic crossbreeds such as Tak and Kabinburi breeds are common in specialised fattening and commercial fattening farms (Boonyanuwat et al., 2009). Crossbred cattle comprised of one-third of the Thai cattle population in 2006 (Waritthitham et al., 2010).

To become more self-sufficient and cut beef imports, the Thai government, through the Department of Livestock Development, has initiated several quality beef cattle breeding projects. Several *Bos Taurus* breeds were imported into the native cattle population by means of frozen semen (Charolais, Hereford, Simmental and Shorthorn) for the purpose of crossbreeding (Charoensook et al., 2013). For example, statistics from the Department of Livestock Development showed that Thailand imported 187,567 doses of beef breed semen in 2005 worth THB 20 million, 135,447 doses in 2006 worth THB 34.35 million and 51,070 million doses in 2007 worth THB 15.16 million (Beefsite, 2009).

One of the cattle improvement projects was implemented in 2001 in the northern province of Tak (Boonyanuwat et al., 2009). The "Tak" breed is named after the province where the breeding station is located. The Tak breed has been developed from the American Brahman and Charolais breeds. American Brahman and Charolais females (50:50) are bred and these are then inseminated with American Brahman semen to produce a 75 per cent American Brahman and 25 per cent Charolais cross. After this, the 75 per cent American Brahman : 25 Charolais crosses are inseminated with Charolais semen, resulting in 62.5 per cent Charolais:

37.5 per cent American Brahman. The breeding station distributes Tak semen which local farmers then use on their native Thai cows (Boonyanuwat et al., 2009).

Another project called 'Kabinburi Cattle Breed Establishment Project' which aimed to produce a new breed of German Simmental (50%) crossed with and Brahman (50%) for dual purposes. 'Kabinburi' was developed from the two breeds combining the strengths of the Brahman breed, including longevity, heat tolerance, insect and disease resistance, durability, grazing ability and calving ease with the superior Simmental traits of fertility, rapid growth, and early sexual maturity led to Kabinburi cattle (Boonprong et al., 2008).

5.3. Disease and veterinary service

The veterinary services in Thailand are provided by the central government and local administrative authorities in collaboration with academic institutions, private veterinarians and livestock industries. The Department of Livestock Development is responsible for animal health, safety of animal-derived products and international animal health matters.

Thailand has conducted several animal disease surveillance programs to enhance the national capability for an early detection and notification of suspected cases or outbreaks of any endemic diseases, zoonotic or emerging diseases that pose threats to animal health and public health. These include active and passive surveillance, and serological surveillance systems for Bovine spongiform encephalopathy (BSE), Brucellosis, and Foot and mouth disease (Department of Livestock Development, 2011).

To improve the early detection and early warning system of animal diseases at the sub-district and village level, over 2000 subdistrict livestock assistants are deployed to work in close collaboration with local authority throughout Thailand. The Surveillances Rapid Response Teams were also established in nine regions of Thailand to respond immediately if an outbreak occurs.

DLD is able to produce vaccines and provide vaccination campaigns including Monovalent Foot and mouth disease, Trivalent FMD, Haemorrhagic disease, Anthrax and Blackleg and Brucellosis.

Thailand has attempted to establish a Foot and mouth disease free zone in the eastern region of the country, which complies with the OIE international animal health codes. FMD surveillance has been conducted to (i) strengthen early FMD detection, (ii) assess protective immunity, and (iii) evaluate the FMD status.

Thailand also established 53 animal quarantine stations throughout the country to control animal movement. In addition, the country also developed the National Livestock Identification and Registration System to identify and trace animal movement and allow animals to be identified individually or by herd.

6. Cattle production systems

There are several cattle production systems in Thailand depending on the investment and potential of producers. However, the cattle industry in Thailand generally can be divided into three main systems:

1. Traditional cow-calf mixed cattle-crop system (averaged 6.8 head per household) is practiced by small cattle households in North-eastern and Central Thailand (Lambertz et al., 2012). Beef animals, mainly native breeds, are mainly raised under extensive grazing in the communal land and are fed with crop residues without supplementation. The efficiency in beef production of this system is low. Farmers normally sell their cattle when they need cash or for income generation to build up wealth or savings, the coverage of expected and unexpected expenses. Cattle manure is used maintain soil fertility in rice production. In this system, the lack of attention by farmers results in low birth weights and high mortality rates, particularly among young animals (Lambertz et al., 2012).

2. Semi-intensive system practiced mainly by market oriented producers. Main breeds for this system are at least 50% Brahman crossbreds. Cattle are fed on grass and rice straw, and supplemented with concentrate for three months in order to increase body muscle. Cattle are also often fattened with pineapple waste as a roughage source.
3. Commercial feedlot (50-100 head) mainly practiced by commercial producers who produce prime and high quality markets with only 1% market share. Breeds are often European crossbred steers are fattened with concentrate, silage and brewery grain for 8-10 months and reached 550-600 kg body weight (Yimmongkol, 2009).

7. The processing sector

Traditionally, beef was supplied unrefrigerated to consumers. This distribution system had a strong impact on the slaughterhouse networks established for market supply. With restructuring in 2002 to place all slaughterhouses under the control of the Ministry of Agriculture and Agricultural Cooperatives, improved figures became available which indicated that of some 791 registered abattoirs, 594 were municipal abattoirs and 197 privately owned. Among these only two met international quality standards, and about one third acquired a slaughter certificate for meeting minimum requirements. Nonregistered abattoirs continue to exist – possibly 40 operate in Bangkok for cattle (Skunmun, 2014).

Slaughtering is mostly done at night in the traditional way (floor dressing). However, there are also a number of new private or government-owned abattoirs with line-slaughter systems with good hygienic standards as the government allowed the private sector to establish small slaughterhouse in each sub-district under the monitoring by veterinary section of sub-district organisation administration.

For prime and quality beef, slaughtering and cutting (retail cut) is done under the slaughterhouse, and dressing room standards; food safety and traceability standards are also required. Some slaughterhouses transport cut carcasses to the market in open-air trucks with no refrigeration.

Health of the cattle before and post-slaughter is inspected by veterinary section (a veterinarian) of the sub-district organisation administration.

8. Beef markets and consumption

The beef markets in Thailand have been classified according to the prices and qualities of the beef. Three classes have been recognized:

- (1) Beef of high quality sold in supermarkets and HRI has been produced in the fattening feedlot, where crossbred cattle are fed for 8-10 months of high grain and low fiber rations to reach final weights between 550 and 600 kg. The beef is tender and has a considerable amount of marbling. The chilling of the half carcasses hanging in a cold room for 1-2 weeks has been practiced by some companies. The market share for this high quality beef has been only 1%;
- 2) Medium quality beef is produced from the Brahman crossbred bulls of different ages 'fattened' for 3 to 4 months in order to increase body muscle and fat. The market share for this medium quality beef class is 49% and carcasses are traded in local fresh markets, supermarkets and HRI;
- 3) Generic beef is sold in wet markets for mostly home consumption. Beef is from native cattle, low Brahman crossbred bulls, culled and old cattle those are scavenging and grazing on communal land without supplementation. The market share for this sector is 50%.

Figure 5 shows that beef consumption has reduced slightly from 3.54 kg per capita per year in 2000 to 2.59 kg per capita per year in 2013. Pork consumption is the highest while beef consumption is the lowest.

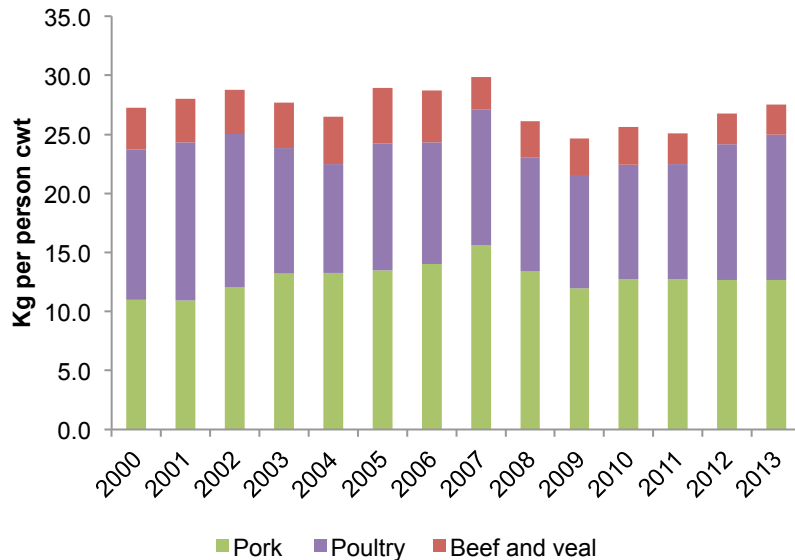


Figure 5: Meat consumption in Thailand

Source: (OECD-FAO, 2014)

9. Beef prices

Thailand's retail prices for cattle meat have risen by over 50% between 2000 and 2013 (Figure 6), reflecting the strong underlying demand growth. This increase in price indicates that domestic production is unable to accommodate increases in demand for beef. The beef price increase conforms to regional and international trends, which suggest an integrated cross-border beef market. The prices of chicken and pork also increased, however at lower rates than the beef price (Figure 6).

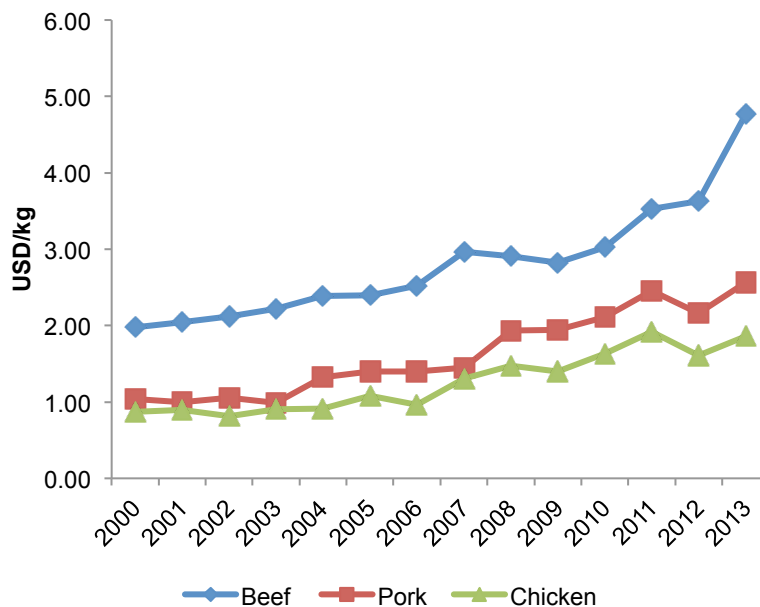


Figure 6: meat retail prices in Thailand (2010 constant prices)

Source: DLD (2014)

10. International trade

10.1. Beef imports

Although, the growth rates of cattle head have been recognised, beef production in Thailand has not been sufficient for domestic consumption. Figure 7 shows that official beef imports to Thailand have increased sharply since 2008. One reason for beef imports increasing was the signing of a free trade between Thailand, Australia and New Zealand in 2005



Figure 7: Beef and buffalo meat import to Thailand

Source: DLD (2014)

The largest beef and buffalo meat supplier to Thailand in the last 8 years was Australia, followed by New Zealand, and USA (Figure 8).

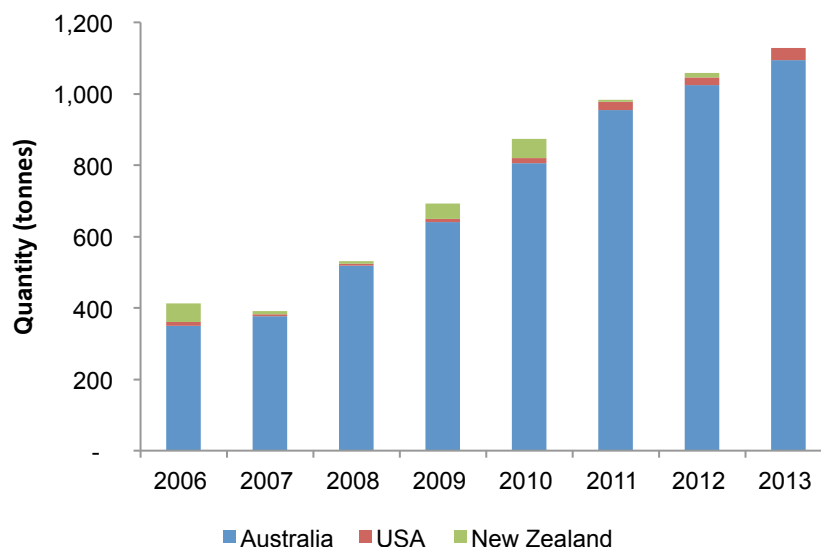


Figure 8: Cattle and buffalo meat import to Thailand by countries

Source: UNComtrade (2014)

Official imports to Thailand have increased significantly since 2010 (Figure 9). The import value increased from 60 million USD in 2006 to 264 million USD in 2013.

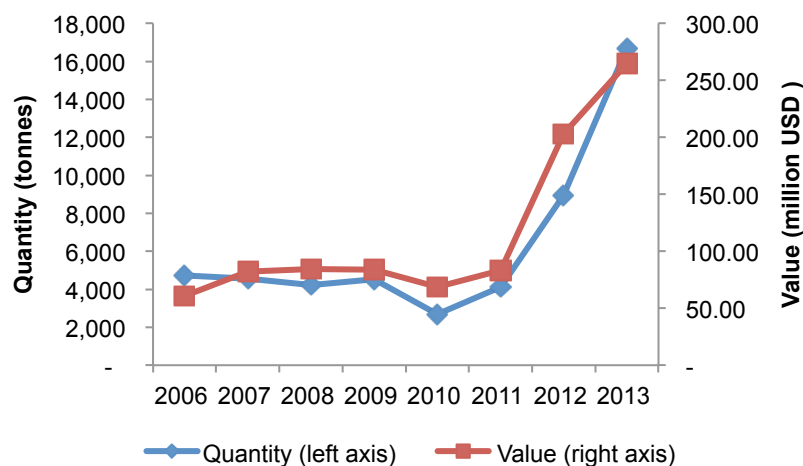


Figure 9: Offal imports to Thailand

Source: UNComtrade (2014)

10.2. Live cattle trade

There are two types of cross-border live cattle movement in Thailand: transit movement of cattle between Myanmar and Cambodia/Laos to Vietnam, and export of local cattle from Thailand to Cambodia/Laos. To import cattle into Thailand, cattle imports must be accompanied by a veterinary health certificate signed by the official authority in the country of origin certifying that (1) the country of origin has been free from endemic diseases for the specified period; (2) the animal has been processed in an approved establishment in sanitary conditions under constant veterinary supervision. Traders who involve in cross-border movement of cattle must obtain a movement permit from DLD.

Live cattle and buffalo from Myanmar imported into Thailand require 21 days quarantine (Ross, 2015). On the 21st day in quarantine every animal is individually inspected for physical signs of FMD, and blood testing also conducted to screen FMD. Cattle movements have increased dramatically since 2006. Figure 8 suggests that number of cattle in transit has grown significantly from 92,000 head in 2006 to 204,665 head in 2013. A reason for this may reflect an improvement in the procedures for monitoring of the transport of the animals.

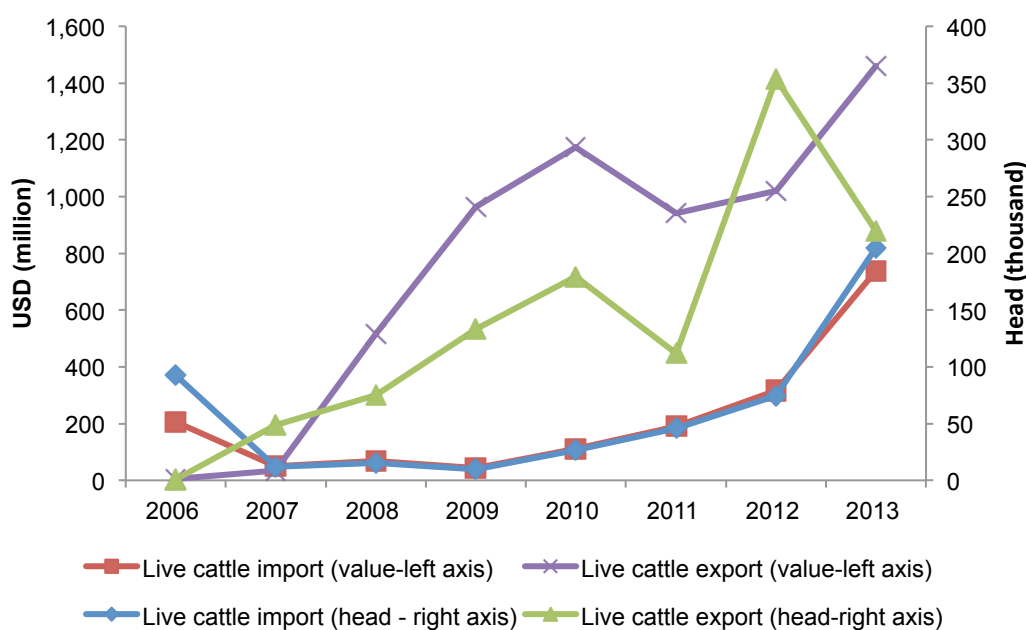


Figure 10: Cattle trade in Thailand

Source: UNComtrade (2014)

However, smuggling cattle from Myanmar is a concern for the Thai government. The cattle from Myanmar are said to harbour diseases such as FMD, which make it difficult for Thailand to successfully implement disease control programs. See Myanmar cattle profile for further information.

Since 2008, cattle from Myanmar have transited through Thailand, and via Cambodia to Vietnam and China. The main entry sites for cattle moving from Thailand to Cambodia are Bantey Meanchey, Oddar Meanchy and Battambang provinces. In each of these provinces, there are several entry points along the border. The majority of cattle imported for transit to Vietnam use the Or Bey Choun and Nang Chan routes. In 2009, up to 150,000 cattle transited via Cambodia to Vietnam, however, in 2013 the number of cattle transited through reduced to only 13,000 head (see Cambodian cattle profile). The reason for the decline in the number of cattle imported from Thailand to Vietnam is that about 40% of imported cattle and buffalo are transported directly to the “Golden Triangle” Mekong River ports in the north of Thailand where they are shipped to south western China via the Mekong discharge ports upstream in northern Myanmar (Ross, 2015). In addition, there has been a significant increase in the number of cattle imported into Vietnam from Australia.

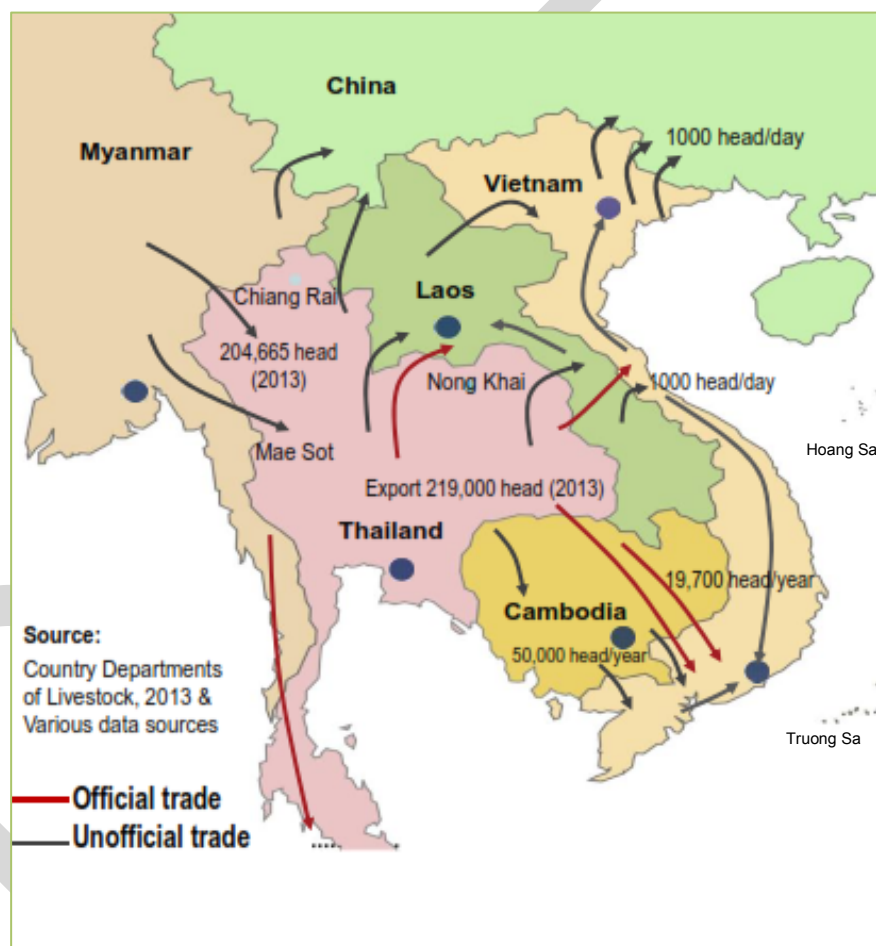


Figure 11: Cattle flows into and out of Thailand

Source: Authors

The export of cattle from Thailand to Laos is primarily to meet demand in Vietnam and China. From the North-eastern Thai river port city of Chiang Rai (Figure 9), about 10,000 live cattle per month in 2014 were shipped on barges up-river to the provincial city of Xishuangbanna in China.

Cattle also cross the Mekong river at Nong Khai to Vientiane in Laos where they are trucked onwards by road to Vietnam. It is suggested by officials that this road trade accounts for about 12,000 head per month in 2014.

The supplies for southern Thailand cattle are supplemented by imports from Myanmar via the river crossing on the Thai-Myanmar border near the North-western town of Mae Sot (Figure 9). About 120,000 cattle and buffalo walked across the river crossing into Thailand during 2014 (Ross, 2015) (further information, see Laos cattle profile).

DRAFT

References

- ADB. 2014. *Key Indicators for Asia and the Pacific 2014* [Online]. Available: <http://www.adb.org/publications/key-indicators-asia-and-pacific-2014> [Accessed March 15 2015].
- BEEFSITE, T. 2009. *Thais Aim to Boost Beef Production* [Online]. Available: <http://www.thebeefsite.com/articles/2026/thais-aim-to-boost-beef-production/> [Accessed April 11 2015].
- BOONPRONG, S., CHOOTHESA, A., SRIBHEN, C., PARVIZI, N. & VAJRABUKKA, C. 2008. Productivity of Thai Brahman and Simmental-Brahman crossbred (Kabinburi) cattle in central Thailand. *International Journal of Biometeorology*, 52, 409-415.
- BOONYANUWAT, K., SIRISOM, P. & APUTHARATANUNG. Year. Improvement of beef cattle genetics provided increasing sustainability of beef cattle production and protein consumption in Thailand. *In: FAO/IAEA International Symposium on Sustainable Improvement of Animal Production and Health, 2009 Vienna, Austria. IAEA and FAO.*
- BOURGEOIS-LÜTHI, N. 2010. *Beef cattle and buffalo trade patterns from Xieng Khouang province, Lao PDR to Vietnam in a rapidly evolving regional marketing context*. MSc in Agribusiness for Development, School of Oriental and African Studies. University of London.
- CHAROENSOOK, R., KNORR, C., BRENIG, B. & GATPHAYAK, K. 2013. Thai pigs and cattle production, genetic diversity of livestock and strategies for preserving animal genetic resources. *Maejo International Journal of Science and Technology*, 7, 113-132.
- COCKS, P., ABILA, R., BOUCHOT, A., BENIGNO, C., MORZARI, S., INTHAVONG, P., NGUYEN, V. L., , BOURGEOIS-LUTHI, N., SCOIZET, A. & SIENG, S. 2009. FAO ADB OIE Study on CrossBorder movement and market chains of large ruminants and pigs in the Greater Mekong SubRegion. FAO, ADB, OIE and SEAFMD.
- DEPARTMENT OF LIVESTOCK DEVELOPMENT 2011. *Animal Health in Thailand*. Department of Livestock Development, Ministry of Agriculture and Cooperatives.
- DFAT. 2014. *Key outcomes of the Thailand-Australia Free Trade Agreement* [Online]. Available: <http://dfat.gov.au/trade/agreements/tafta/Pages/key-outcomes-of-the-thailand-australia-free-trade-agreement.aspx> [Accessed April 25 2015].
- DLD 2014. *National Animal Statistics*. *In: DEVELOPMENT, D. O. L. (ed.). Bangkok, Thailand.*
- FAO 2005. *Livestock Sector Brief: Thailand*. FAO.
- LAMBERTZ, C., CHAIKONG, C., MAXA, J., SCHLECHT, E. & GAULY, M. 2012. Characteristics, socioeconomic benefits and household livelihoods of beef buffalo and beef cattle farming in Northeast Thailand. *Agriculture and Rural Development in the Tropics and Subtropics*, 113, 155-164.
- OECD-FAO. 2014. *OECD-FAO Agricultural Outlook* [Online]. OECD-FAO. Available: http://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2014_agr_outlook-2014-en [Accessed].
- OFFICE OF AGRICULTURAL ECONOMICS. 2014. *Agricultural Statistics* [Online]. Available: http://www.oae.go.th/main.php?filename=index__EN [Accessed].
- PHOMMEXAY, P., SATASOOK, C., BATES, P., PEARCH, M. & BUMRUNGSRI, S. 2011. The impact of rubber plantations on the diversity and activity of understorey insectivorous bats in southern Thailand. *Biodiversity and Conservation*, 20, 1441-1456.
- ROSS, A. 2015. *Southeast Asian Beef Market report* [Online]. Available: <http://seabeefreport.com/2015/03/17/its-a-small-world/> [Accessed 30 April 2015].
- SKUNMUN, P. 2014. The Bovine Hide Industry in Thailand. *Asian Agri-History* 18, 153-166.

- SKUNMUN, P., POONDUSIT, T., KOGA, A. & CHANTALAKHANA, C. Year. Changes of Cattle and Buffalo Production in Village Farming Systems and Their Long-term Impacts on Buffalo Raising. *In: Proceedings Buffalo Workshop 2001*.
- UNCOMTRADE. 2014. *The United Nations Commodity Trade Statistics Database* [Online]. Available: <http://comtrade.un.org/db/default.aspx> [Accessed 16 July 2014].
- UNDP. 2014. *The Millennium Development Goals* [Online]. Available: <http://www.th.undp.org/content/thailand/en/home/countryinfo.html> [Accessed 20 April 2015].
- WARITTHITHAM, A., LAMBERTZ, C., LANGHOLZ, H. J., WICKE, M. & GAULY, M. 2010. Assessment of beef production from Brahman x Thai native and Charolais x Thai native crossbred bulls slaughtered at different weights. II: meat quality. *Meat Sci*, 85, 196-200.
- WORLD BANK. 2011. *Thailand Now an Upper Middle Income Economy* [Online]. Available: <http://www.worldbank.org/en/news/press-release/2011/08/02/thailand-now-upper-middle-income-economy> [Accessed 27 April 2015].
- WORLD BANK. 2014. *World Bank Database* [Online]. Available: <http://data.worldbank.org/indicator/NY.GDP.PCAP.CD> [Accessed 10 Dec 2014].
- YIMMONGKOL, S. 2009. *Research and Development Projects on Improvement of the Potential Use of Dried Cassava Pulp and Cassava Leaf Meal in Concentrate of Feedlot Cattle* PhD, Kasetsart University.