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21

Guiding policies and investments to reduce agriculture-led deforestation in Viet Nam

Expanding beef and dairy sectors, while reducing deforestation risks

FAO AGRICULTURAL DEVELOPMENT ECONOMICS TECHNICAL STUDY

21

Guiding policies and investments to reduce agriculture-led deforestation in Viet Nam

Expanding beef and dairy sectors, while reducing deforestation risks

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Preface

Agriculture development in Viet Nam has been long linked to deforestation. Despite the optimistic overall forest cover trends reflected in general statistics, following the government's commitment to halt deforestation, there is still evidence that development of agricultural value chains may provide incentives to deforest in some of the country's areas. While historically the main "forest-risk" commodities included rubber, coffee, cashew, or tea produced for exports, the prospective shift of Viet Nam's agricultural sector towards increasing the value added may induce other commodities' contribution to deforestation.

Sustaining agricultural growth through increasing value added is key for the country's economic development and food security concerns. Viet Nam identified beef and dairy products among priority commodities that have a great potential in contributing to this objective, and it is promoting their production through a wide range of explicit and implicit policy instruments, including price incentives. However, the impetus and ambition to expand domestic production of both beef and dairy products, create an inherent risk that pasture and feed crop expansion becomes a primary driver of deforestation and forest degradation. Given that land constraints (both availability and use) become increasingly binding, the demand for additional land will significantly increase the risks of deforestation and forest degradation, against the government's efforts.

The Agrifood Economics Division (ESA) of Food and Agriculture Organization of the United Nations (FAO) in Rome, with the support of the FAO Office in Viet Nam (FAO VN) and the Institute for Policy and Strategy for Agriculture and Rural Development (IPSARD), has committed to provide insights on how policies and investments could be re-oriented to put agriculture on deforestation-free development pathways. This study, prompted by agreement with the previously-existing FAO Strategic Programme 2 to make agriculture, forestry and fisheries more productive and sustainable (SP2), suggests a set of key policy reforms to transform the general agricultural sector as well as the specific dairy and beef sectors to ensure agricultural growth does not come at the expense of forest loss.

The study unpacks the potential, current and future, linkages between beef and dairy development and deforestation, using Nghe An and Ha Tinh provinces in Viet Nam as case study, where the beef and dairy production increases are important and potential impact on the primary forests is of particular concern. It shows how beef and dairy expansion creates demand for additional land, which combined with existing land constraints, increases risk of further deforestation. The study also proposes possible entry points for developing deforestation-free value chains, which are key for decision-makers to enact new policies to overcome the dual challenge of agriculture growth without forest loss, which is likely to intensify if no action is taken.

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Abbreviations and acronyms

5MHRP	5-Million-Hectare Reforestation Programme
BBB	Belgian Blue Beef
CIFOR	Center for International Forestry Research
FAO	Food and Agriculture Organization of the United Nations
FDS	Forest Development Strategy
FIPI	Forest Inventory and Planning Institute
FLEGT	Forest Law Enforcement, Governance and Trade
GDP	gross domestic product
GFW	Global Forest Watch
GHG	greenhouse gas
GRIP	Global Roads Inventory Project
GSO	General Statistics Office of Viet Nam
HF	Holstein-Friesian
IPSARD	Institute for Policy and Strategy for Agriculture and Rural Development
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
MARD	Ministry of Agriculture and Rural Development
NDDP	National Dairy Development Plan
NFIMAP	National Forest Inventory, Monitoring and Assessment Programme
NGO	non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OLS	ordinary least squares
PES	payment for ecosystem services
PSE	producer support estimate
RAFC	Rural, Agriculture and Fishery census
REDD+	Reducing emissions from deforestation and forest degradation
RLDP	Rice Land Designation Policy
SDM	Spatial Durbin Model
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
VC	value chain

Executive summary

Over the past three decades, Viet Nam's agricultural sector has made tremendous progress. The *Đổi Mới* reforms set in motion during the mid-1980s have led to strong economic growth and development. Following the reforms, the agricultural sector in Viet Nam underwent significant structural changes and the country transitioned from a net agrifood importer to a major exporter of agricultural products.

Agricultural sector development, however, played a key role in deforestation in Viet Nam through the expansion of agricultural land reinforced by land and land-use policies and restrictions. Most of the Viet Nam's agricultural growth stemmed from the expansion of agricultural land at the expense of rapid deforestation. Subsequent land policy reforms also introduced additional pressures on land through restrictions on the land size per farm as well as choice of commodity to be produced in designated areas. Even if today only the restriction on land devoted to rice cultivation is actually binding, it increases the demand for agricultural land.

Viet Nam has also made remarkable progress in increasing forest cover due to several key policies and interventions, put in place since the 1990s, to strengthen forest management and protection and promote reforestation. Yet, while the overall forest cover has increased, natural primary forests continue to degrade and disappear. Planted forests drive the positive trend in forest cover, expanding by almost five times between 1990 and 2020 (see Figure 5). Natural forest cover appears quite stable; however, this is a net result of natural regeneration and regrowth offsetting declining natural forest. Moreover, natural forest has been degrading and is increasingly composed of impoverished secondary forest, while currently, primary forest makes up only around 0.5 percent of total forests in Viet Nam (FAO, 2020). The ongoing substitution of natural forest with planted forest highlights that some deforestation is still taking place, which satellite data[1] analysis confirms (see Figure 7). As a result, Viet Nam is observing an unintended change in the quality of its forest coverage, which may expose the country to many environmental threats if not tackled properly. Many of the existing regulations and inefficient governance act as barriers for effective deforestation control including inadequate land administration, budgetary constraints of forest protection departments, forest law compliance issues and weak monitoring and enforcement.

Domestic population and economic growth will continue to increase demand for Viet Nam's agricultural lands and agriculture is likely to remain the biggest threat to deforestation. If Viet Nam's reforestation success story is to continue, the country will need to find ways to use existing agricultural lands more productively.

Viet Nam recognizes that future growth in the agricultural sector must come from improving and increasing value addition with beef and dairy products among the priority commodities. Their demand in Viet Nam is surging, due to increasing incomes, affluent consumers, continued urbanization, and changing dietary habits. However, domestic production merely met 30 percent of the demand in 2020. As a response, Viet Nam developed a comprehensive Livestock Development Strategy for the period from 2021–2030,

[1] The "tree cover" data from Global Forest Watch platform (Hansen *et al.*, 2013), used for this analysis, refer to trees in plantations as well as natural forests. The "tree cover loss" is the removal of tree canopy due to human or natural causes, including fire and does not take tree restoration or regeneration into account. Therefore, it may not be an adequate indication of net change and may overestimate deforestation. Focusing on tree cover loss within undisturbed primary forests, however, allows us to highlight some of the most critical forest areas where loss is likely to have long–term impacts. Further, plantation harvests made up only 8 percent of all tropical tree cover loss from 2013 to 2019 (Harris, Goldman and Gibbes, 2019), indicating that the overestimation, if in place, is likely to be marginal.

with a vision to 2045 and is promoting beef and dairy production through a wide range of explicit and implicit policy instruments, including price incentives.

Yet, expanding beef and dairy sectors require land dedicated to livestock and expansion of pasture for cattle has been the dominant driver of deforestation globally. About 40 percent of the global deforestation is associated with expanding pastures for cattle. While in Viet Nam the embodied deforestation for cattle, and in particular expansion of pasture, between 2013 and 2017, is only around eight percent, it is right behind rubber (19 percent), vegetables (19 percent) and rice (12 percent) (Pendrill, Persson and Kastner, 2020).[2]

Nghe An and Ha Tinh – the two main provinces identified by the government as priority areas for beef and dairy sector development – have significant natural forest areas with most of the country's remaining primary forests. The production of beef and dairy has been increasing in regions where the remaining natural forests are located, in particular North Central and Central Coast regions. In the absence of strategic policies, the increase in production will likely require additional land due to the small size of available grasslands in the country and thereby increase risks of deforestation and degradation as land constraints (both availability and use) become increasingly binding.

In Nghe An and Ha Tinh, cow rearing is positively and significantly correlated with tree cover loss in 2016[3] indicating that increasing livestock numbers in these provinces is associated with higher risk of deforestation. At the national level, an increase of 1 percent in cow heads per capita is correlated to an increase in tree loss by 0.13 percent. For Nghe An and Ha Tinh, the correlation is much stronger – an increase of 1 percent in cow heads per capita is correlated to an increase in tree loss by 3.4 percent. The results also highlight the presence of positive spatial correlation between cow rearing and tree cover loss in nearby communes. The results from the analysis, however, do not say anything about causality. While the study finds a positive and significant correlation between cow rearing and tree cover loss, it is unable to conclude whether the tree cover loss was caused by the increased cow rearing activities alone due to unavailability of data required for establishing a causal effect.

The value chain analysis of beef and dairy in Nghe An and Ha Tinh concludes that their current structure and development paths create additional agricultural land demand pressures and increase deforestation risks either directly or indirectly. The dairy value chain in Nghe An and Ha Tinh is dominated by two large dairy companies – Vinamilk and TH Milk that produce almost all the raw milk and engage in processing and distribution (see Figure 24). Only a small share of raw milk is produced by small and medium-scale dairy farmers under the contract with Vinamilk. The production system of dairy companies is highly efficient, of high-quality standards, thanks to the technologically advanced herd management tools employed. The large size of the cow herds entails huge feed requirements

[2] Data on the proportion of deforestation attributable to specific agricultural commodities is lacking. The most reliable estimate is Pendrill, Persson and Kastner (2020)'s calculation, based on land use change and tree cover loss maps.

[3] Using the Global Forest Watch platform (Hansen *et al.*, 2013) on tree cover extent and annual tree cover loss from 2011 to 2016, this study analysed possible linkages between deforestation and production of beef and dairy in Nghe An and Ha Tinh provinces. While tree cover loss is not the same as deforestation, we purposefully use the term "tree cover loss" interchangeably with "deforestation" or "forest cover loss" throughout this analysis. The tree cover data includes tree plantations and agricultural tree crops and may also include harvesting cycles of plantations. However, plantation harvests made up only 8 percent of all tropical tree cover loss from 2013 to 2019 (Harris, Goldman and Gibbes, 2019) and in the absence of spatially explicit multi–temporal datasets for rubber and wood fibre plantation extent which are the predominant varieties in Viet Nam, the study is unable to mitigate the impact of plantation harvesting cycles. The authors acknowledge that ignoring this might result in an overestimation, albeit small, of forests replaced if tree cover loss was associated with plantation harvest dynamics rather than plantations or other agricultural commodities replacing natural forests. And this risk is particularly high in the selected provinces where historically planned conversion of mainly poor natural forests to rubber, and other plantation crops has been a significant driver of deforestation (MARD, 2018a).

(especially maize), high resource-intensity (e.g. water), and requires strong infrastructural support (buildings, roads, etc.). The highly efficient structure of the dairy value chain makes it unlikely that subsequent increases in production can be achieved through further intensification of production, while establishing new dairy farms or expanding existing ones will require additional land.

Beef value chain is extremely inefficient with a strong potential for improving productivity and increasing production within the existing capacity (see Figure 25). The beef value chain is still very traditional and the different value chain stages are rather basic and fragmented. The smallholder production system dominates, with some medium to large commercial farms emerging only recently. Processing is at a very early stage and lacks modern infrastructure and equipment, including cold storage. The large share of meat, particularly coming from small family farms, is sold without cooling at the local markets. As a result, the value chain is locked in a low productivity, low profitability, and low efficiency cycle. If no action is taken to restructure and modernize the beef value chain, the future production expansion will require increased land devoted to cow rearing for beef.

It is highly likely that to feed the growing number of animals, more land may be destined to animal grazing by an expansion of pastures or additional land to grow fodder crops increasing the risks of further deforestation. Increasing numbers of beef and dairy cows will need additional grazing land, more forage, more grains, and more feed concentrates. As the feed in both sectors comes in great majority from locally produced crops and the feed crop land area has been already expanding, this trend is very likely to continue in the future increasing further the demand for additional agricultural land. While no free agricultural land exists, the additional land will need to come either from conversion from other uses within the sector, or more likely, outside the agricultural sector. Given the high competing demands for land from various sectors of the economy and existing land use constraints within the agricultural sector, the need for additional land would likely increase the risks of further deforestation.

Additional land pressure from beef and dairy sector development is less bound to come at the expense of deforestation if key policy reforms and investments take place. The policy and investments mix will require a combination of general agricultural sector related actions and those specifically targeted towards beef and dairy sectors. Overall, they must address constraints on agricultural land, enable agricultural transformation and tackle existing inefficiencies to create a modern, sustainable, and productive beef and dairy sectors.

To support tackling the dual challenge of sustaining growth in the agricultural sector, and in particular beef and dairy, while increasing efforts to reduce forest cover loss, the study suggests a set of key policy reforms. The list is certainly not exhaustive but constitutes a starting point for stakeholder round-table discussions to determine the sustainable agricultural development pathway.

General orientation of agriculture sector development should:

- **Reduce barriers that limit the possibility of moving from low value commodities to higher value fruit and vegetable or beef and dairy production on existing agricultural land.** This will require:
  - Removing restrictions on agricultural land use to allow farmers freely choose the commodity to produce and respond to market signals.
  - Enabling land consolidation to achieve economies of scale by removing land size upper limits and the restrictions to land transfers.
  - Ensuring enforcement of land use rights, that all farmers receive their land use certificates and limiting compulsory land conversions.

- Enhancing transparency in land management to reduce risk of corruption and avoid illegal acquisition of land.

- **Improve access to finance and availability of farm credit to promote investments in modern and efficient farming technologies** necessary for increasing yields, quality, and value addition which lead to increased productivity within existing limits of agricultural land.
- **Improve rural education, training and extension services** including re-orientation towards improving farm management skills, which are key to ensure farmers and other businesses in the agricultural value chains can fully benefit from existing technologies to improve their production and processing systems.
- **Facilitate labour mobility across sectors and across regions** to support production, income diversification and structural transformation. Structural transformation of the agricultural sector towards more modern, productive, and yielding high-quality products may require less competitive producers and businesses to move out of the sector and it is important to help such labour adjust to the shifting demands of the market.
- **Promote creation of new farm cooperatives and strengthen the existing ones**, to help achieve economies of scale, improve market position in both input and output markets, share knowledge and improve the technology of production, among others.
- **Improve the availability and access to market information systems**, aimed at enhancing producers' chances to harness existing market opportunities, currently limited in terms of information on prices and demand trends.
- **Improve linkages between various stages of commodity value chains** including increased use of formal contracts and reducing information asymmetry between different actors to improve overall efficiency of the value chain through better planning, reduction of waste and secured earnings.
- **Continue to reinforce compliance of existing legislation and regulations to protect forests.** Adequate environmental regulations, comprehensive monitoring, compliance, and enforcement of the legislation remains a key element to protect the remaining forests.

Beef and dairy sectors specific orientation should:

- **Ensure that the production increases in beef and dairy sectors are achieved through higher productivity rather than creation of new beef and dairy farms.**
  - Further increases in beef production should be achieved through farm modernization and restructuration that would enhance their productivity. To avoid deforestation, this must be done within the existing limits of agricultural land.
  - The existing dairy farms are already modern and highly efficient with little room for improvement in productivity, hence, further increases in dairy production may lead to establishing new dairy farms (or expanding the size of existing ones). It is critical to ensure that this happens through conversion of existing farms into dairy producing businesses. The government should also invest in agricultural research and innovation to search for new technologies that would allow the increase of the productivity frontier for the existing dairy farms.
- **Ensure that intensification of beef and dairy systems are indeed capable of sparing land, and do not create pervasive incentives to increase deforestation in pursuit of higher profits by private agents.**
- **Ensure that increasing demand for feed is met by production within existing agricultural land.** Removing any existing price incentives to produce many of the crops used for feed and allowing farmers to respond to market signals within the existing agricultural land, would reduce the supply response and increase reliance on imported feed.

- **Promote sustainable grazing systems, including silvopastoral approaches that can improve both environmental quality and productivity.**
- **Develop and strengthen processing infrastructure, including modern, mechanized slaughterhouses, and promote the use of cold chains** to enhance productivity and product quality, and eventually harness the growing market opportunities. This should be accompanied by ensuring compliance with food safety standards.
- **Continue to increase the role of international trade in satisfying the growing internal demand for beef and dairy products**, alongside the current expansion of domestic production. Increased exposure to international trade will not only reduce domestic production pressures, and hence pressures on acquiring additional land, but has also the potential to enhance knowledge sharing and technology transfer, and increase competition and competitiveness of domestic producers while stimulating increasing quality of products.
- **Develop a future roadmap for livestock supply chain traceability as a complement to current forest monitoring, reporting and verification systems that can also feed into its upcoming national portal on product traceability**.

1 Introduction

Agriculture remains a cornerstone of Viet Nam's economy and the expansion of agricultural land for producing agricultural commodities has been a significant driver of deforestation in the country for many years. However, Viet Nam has moved away from a period of severe deforestation with remarkable progress in improving the forest cover. Yet, these positive gains continue to face considerable pressure from the land-use demands of the continuously growing agricultural sector and the associated loss of forests, particularly natural forests, remains a major challenge in some parts of the country. Between 2000 and 2015, land under the production of agricultural "forest-risk" commodities, including rubber, cassava, coffee, maize, cassava, and tea, increased to roughly 4 percent of Viet Nam's total land area. Given the scarce land resources in Viet Nam, a significant share of this expansion comes at the expense of losing Viet Nam's forests.

Sustaining agricultural growth is important for Viet Nam's economic development and food security concerns stemming from increasing population pressures, yet this cannot be achieved at the cost of losing forests. Forests have a critical role to play: they are the key element in the fight against climate change that threatens the productivity of the agricultural sector. Deforestation releases carbon stored in branches, leaves, trunks, roots, and soil, contributing to increasing anthropogenic greenhouse gas (GHG) emissions that accelerate the speed of climate change. Decreasing the rate of deforestation will help to reduce emissions, while improved forest management, afforestation, and reforestation will contribute to enhancing carbon sequestration, increasing the potential to slow down climate change. Natural forests also provide a wide range of other ecosystem services and are central to environmental conservation efforts.

To address the dual challenge of maintaining robust economic growth in the agricultural sector, while increasing efforts to reduce forest cover loss, Viet Nam must develop policies and investment strategies to promote the transition to a deforestation-free agricultural development pathway. The Government of Viet Nam recognizes this challenge and has concentrated its efforts on improving the agricultural sector's competitiveness and environmental sustainability, including reduced deforestation and forest degradation through boosting productivity in the existing agricultural lands and improving agricultural value-added.

Pursuing these efforts, Viet Nam identified beef and dairy products among priority commodities that have a great potential in improving agricultural value-added. Their demand in Viet Nam is surging as a result of socioeconomic factors such as rising incomes, urbanization, and population growth, and changing dietary habits. However, domestic production does not meet internal demand. Given the strong demand and opportunities for value-addition in the beef and dairy sector, Viet Nam is promoting their production through a wide range of explicit and implicit policy instruments, including price incentives.

However, the impetus and ambition to expand domestic production of both beef and dairy products, create an inherent risk that pasture and feed crop expansion – necessary to support increasing cattle production for beef and dairy – becomes a primary driver of deforestation and forest degradation. This is because the production of beef and dairy has been particularly increasing in regions where the remaining natural and primary forests are located, in particular the North Central and Central Coast regions. Given that land constraints (both availability and use) become increasingly binding, the demand for additional land will significantly increase the risks of deforestation and forest degradation, against the government's efforts.

Given the importance of beef and dairy production in the future growth of the agricultural sector in Viet Nam, the concentration of their production in forested areas, as well as their global acclaim as "forest-risk" commodities, this study focuses on beef and dairy. It excludes other commodities, some of which may be more related to deforestation in Viet Nam, but which have already been extensively studied (for example rubber, coffee, pepper and other cash crops).

This study aims at providing insights into the relationship between beef and dairy sector expansion and deforestation in Viet Nam to inform the policy makers on possible entry points to reduce the deforestation risks. In particular, the study attempts to demonstrate whether beef and dairy already represent a threat to the forests and explores how this relationship might evolve in the future. The study also tries to unpack the possible linkages between beef and dairy production and deforestation to identify entry points for government interventions. The analysis is focused on two provinces located in the North Central and Central Coast regions: Nghe An (Vietnamese: *Nghệ An*) and Ha Tinh (Vietnamese: *Hà Tĩnh*), where the beef and dairy production increases are important and potential impact on the primary forests is of particular concern. It adopts a mixed-method approach that combines a descriptive analysis of forest cover trends and cow rearing in the provinces; an empirical analysis of the correlation between cow rearing and tree cover loss at the commune level; and a value chain analysis for dairy and beef sectors in the selected provinces to unpack the potential channels of impact.

The study is structured as follows. Chapter 2 focuses on a general assessment of developments in the agricultural sector, national forest cover change, and the relationship between the two. Section 2.1 focuses on the agricultural sector in Viet Nam, exploring the role of land policies and agricultural land expansion in agriculture sector growth. Section 2.2 provides a historical overview of forests and forest cover change in Viet Nam, while Section 2.3 summarizes the main agriculture-related deforestation drivers. Chapter 3 outlines the prospective shift in strategy of the agricultural sector towards increasing value-added, and sheds light on potential consequences for deforestation. Chapter 4 analyses current trends and future projections of dairy and beef sectors, as playing a key role in enhancing agricultural value-added. Chapter 5 of the study focuses on two provinces, Nghe An and Ha Tinh, as a case study to analyse in detail the relationship between forest cover loss and developments in the dairy and beef value chains. Section 5.1 presents an overview of agricultural sector development and the trends in forest cover change, with Section 5.2 focusing on cow rearing for beef and dairy – in the two provinces studied. Section 5.3 provides an empirical analysis of the relationship between deforestation and cow breeding in the selected provinces. Section 5.4 provides more insights to the dairy and beef sectors through value chain analysis. Section 5.5 explores in detail the empirical results to unpack the linkages between beef and dairy sectors and deforestation. Chapter 6 of the study outlines key policy reforms and investments that are necessary for ensuring deforestation-free developments in the two value chains, some of which address the agricultural sector as a whole.

2 Agriculture and forestry nexus in Viet Nam: a historical perspective

KEY MESSAGES

- Over the past three decades, the agricultural sector has made tremendous progress, mostly driven by agricultural land expansion following policy reforms implemented in the mid-1980s.
- Agricultural land expansion has slowed down in recent years, yet it remains of concern as the demand for agricultural land remains high and competes with non-agricultural land uses.
- After a long period of deforestation driven by agricultural land expansion, Viet Nam has made remarkable progress in increasing forest cover; however, the observed increases are due to massive forest planting, while natural forests are continuously degrading and decreasing.

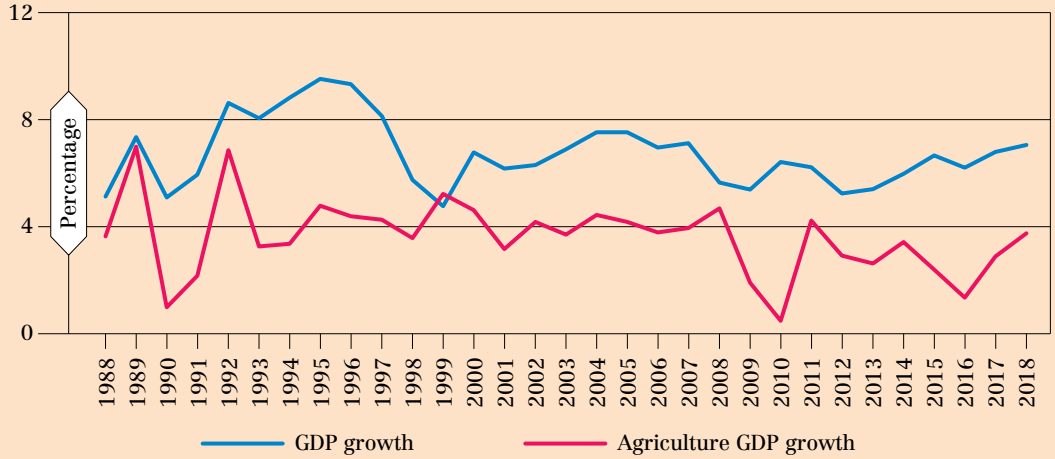
2.1 Growth of agricultural sector driven by agricultural land expansion following major policy reforms

Viet Nam has a land area of 310 000 km² of which about 39 percent is currently devoted to agriculture. About two-thirds of Viet Nam's 96 million population live in rural areas and about 41 percent are employed in agriculture. While the relative importance of agriculture in the economy has declined over time, the overall gross domestic product (GDP) and population growth have continued to increase at a rapid pace resulting in a continuous expansion of all sectors of the economy, including agriculture. The agricultural sector growth has been associated with the increase in the share of agricultural land, which also continued to grow, even if at a slower pace in most recent years (World Bank, 2020) (see Table A1 in Annex 2).

A series of important economic policy reforms were the main drivers of the fast economic development, agricultural sector expansion and increased amount of land devoted to agriculture. Since the launch of *Đổi Mới* (Renovation) reform in the mid-1980s, Viet Nam has started a gradual move away from a central planning economy towards increasing market openness, including in the agricultural sector (OECD, 2015). Reforms generated a rapid economic expansion with the average annual GDP growth oscillating between 5 and 10 percent, to large extent driven by growth in the agricultural sector (see Figure 1).

Following the *Đổi Mới* reforms, the agricultural sector in Viet Nam underwent significant structural changes, leading to a transition from a net agrifood importing country to a major exporter of agricultural products, including staple crops such as rice and cassava, and perennial crops such as rubber, cashew nuts, black pepper, and coffee. It also significantly increased the production of livestock, and more recently dairy, for the domestic market. Yet, the value chains remain relatively short, and exports consist of relatively low-value un-processed commodities (OECD, 2019).

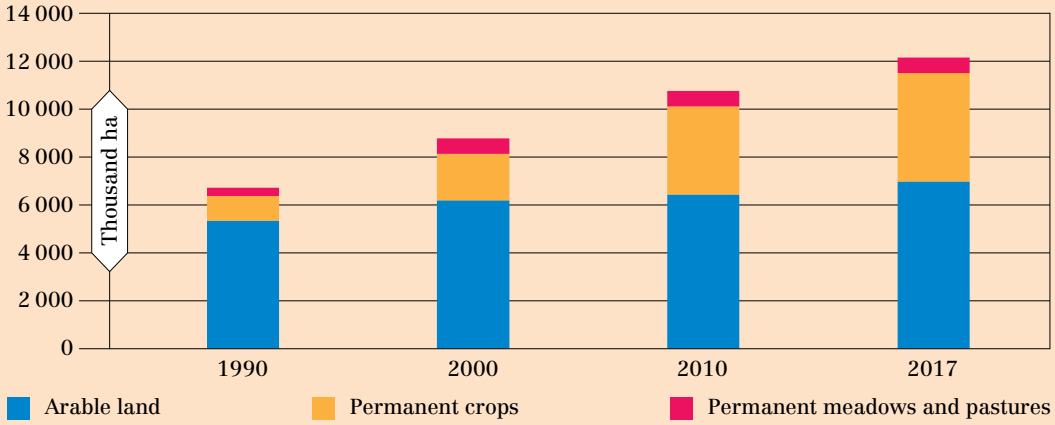
FIGURE 1 Annual gross domestic product (GDP) and agricultural GDP growth, 1988–2018



Source: World Bank. 2020. *World Development Indicators*. Washington, DC. Cited 15 November 2021. https://databank.worldbank.org/source/world-development-indicators

The expansion of the agricultural area has been one of the key factors contributing to growth in the agricultural sector. The agricultural area has virtually doubled since the 1990s and about two-thirds of the land increase occurred in the 1990s following a massive natural forest conversion to agricultural activity, mainly coffee and rubber. In the 2000s the increase of agricultural land was much slower. This reflected the lower amount of land that could be potentially converted, as well as greater competition for remaining land between various sectors of the economy, reinforced by the initiation of environmental protection policies including forest protection (Meyfroidt, Phuong and Anh, 2013; OECD, 2015; Pham *et al.*, 2012; Pham *et al.*, 2019). Currently, agricultural land is about 12 million hectares (ha) of which 57 percent is devoted to annual crops, 37 percent to perennial crops and 5 percent to permanent pastures and meadows (see Figure 2).

FIGURE 2 Distribution of agricultural land in Viet Nam, 1990–2017



Notes: Arable land includes temporary crops, temporary meadows and pastures, and land with temporary fallow. Total cropland area can be derived by the sum of arable land and permanent crops. Agricultural land is the sum of total cropland and permanent meadows and pastures.

Source: FAO. 2020. FAOSTAT. In: *FAO*. Rome. Cited 15 December 2021. www.fao.org/faostat/en/#data

Despite the significant agricultural land expansion, agricultural land availability per farm remains scarce. The high population growth accompanying the expansion of agricultural land resulted in merely 0.13 ha of agricultural land per capita and 0.2 ha per farm in 2016 (GSO, 2016). The majority of farmers manage very small parcels of land. According to the 2016 Rural, Agriculture and Fisheries Census (RAFC) data, more than 80 percent of farmers operate on no more than two ha and nearly 50 percent on less than 0.5 ha. The scarcity of agricultural land increases incentives for farmers, particularly the vulnerable smallholders, to continue the land expansion, often in unauthorized or protected areas such as natural forests, either for agricultural or commercial forestry activities to increase their incomes.

The subsequent land policy reforms have introduced additional pressures on land through restrictions on the choice of commodity to be produced in designated areas (see Box 1), dictated by self-sufficiency policies aimed at increasing the country's food security (see Box 2). Today, only the restriction on land to be devoted to rice cultivation is actually binding.

BOX 1 Land reforms in Viet Nam

In Viet Nam, all land is owned and administered by the state on behalf of the people. Following the *Đổi Mới*, the Land Law of 1993 gave farmers a wide range of usufruct rights including the rights to rent, buy, sell, inherit the land and use it as collateral to obtain loans. However, the subsequent revisions in 1998, 2003 and 2013, introduced restrictions on land use and allowed the state to appropriate land for economic development purposes (OECD, 2015). Today, most of the land-use constraints are not binding and farmers may grow the commodity of their choice, except for land dedicated to the cultivation of the main staple-rice. Under the Rice Land Designation Policy (RLDP), about 35 percent of agricultural land is dedicated to rice, and conversion of paddy fields to other land use requires special permission from the district level government, which are rarely granted (Le, 2020). As a result, farmers can use their land only within the predefined range of activities.

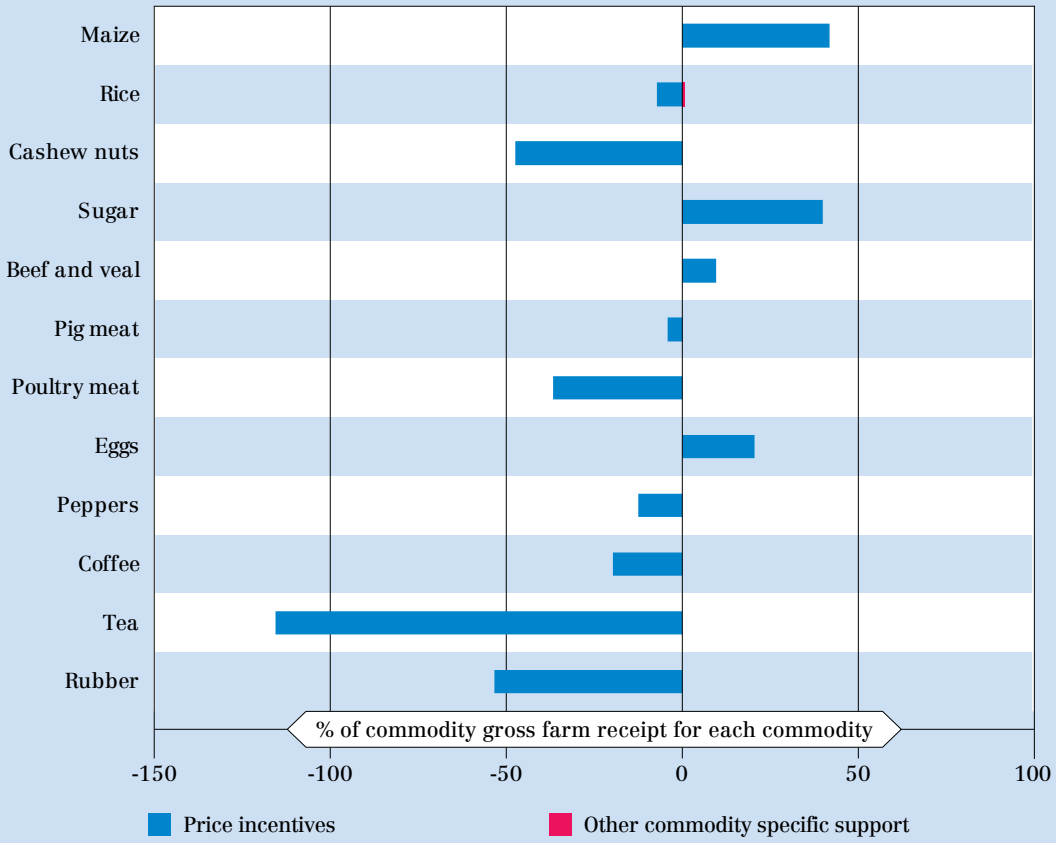
Source: OECD. 2015. *Agricultural Policies in Viet Nam 2015*. Paris, OECD Publishing. Cited 21 September 2021. http://dx.doi.org/10.1787/9789264235151-en; Le, K. 2020. Land use restrictions, misallocation in agriculture, and aggregate productivity in Vietnam. *Journal of Development Economics*, 145. 10.1016/j.jdeveco.2020.102465

BOX 2 Government support to agricultural commodity production in Viet Nam

The policy mix results in overall negative support to agricultural producers in Viet Nam. In 2017–2019, on average, the producer support Estimate (PSE) was equal to -7.1 percent of gross farm receipts suggesting implicit overall taxation of the agricultural sector. As the subsidies are relatively small, this result is driven by a mix of producer price incentives and disincentives. While producers of exported commodities are implicitly taxed, producers of import-competing commodities, such as maize, sugar cane and beef, benefit from positive price incentives which stimulate the domestic production of these commodities and reduce their imports (see Figure 3).

BOX 2 (cont.) **Government support to agricultural commodity production in Viet Nam**

FIGURE 3 **Support to production of agricultural commodities in Viet Nam, 2017–2019**



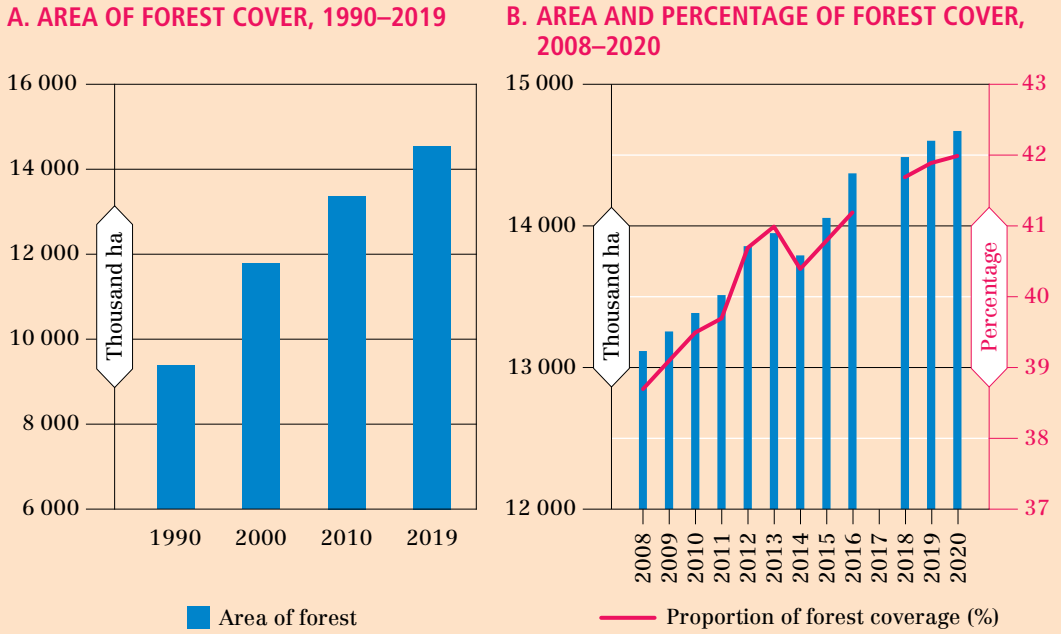
Source: OECD. 2020. *OECD Agriculture Statistics*. Paris. Cited 21 September 2021. http://dx.doi.org/10.1787/agr-pcse-data-en

2.2 Forest transition in Viet Nam and the role of policies

Forests in Viet Nam suffered a long period of exploitation and degradation beginning from the 1940s until the 1990s. According to the World Conservation Monitoring Centre (WCMC), the share of the country's area covered by forests declined from about 43 percent in the 1940s to roughly between 16 and 27 percent in the early 1990s (de Koninck, 1999) following warfare (before 1975), timber exploitation and clearing forests for agriculture land expansion (particularly in the mid-1980s following the *Đổi Mới* reforms).

After a long period of rapid deforestation, forest management and conservation became one of Viet Nam's top priority agendas resulting in restructuring and reorienting of the entire state forestry governance system, initiated already during *Đổi Mới*. In the mid-1990s, afforestation and reforestation outpaced deforestation and Viet Nam has been acclaimed as the first country in Southeast Asia to achieve this. According to international and national statistics (FAO and GSO), in 2020 forest cover area almost achieved pre-deforestation levels (42 percent, 14.7 million ha) and has been continuously increasing since the 1990s (see Figure 4).

FIGURE 4 Increase in forest cover area in Viet Nam



Note: In panel b data for 2017 are not available.

Sources: Panel A: FAO. 2020. *Global Forest Resource Assessment 2020.* Rome. Panel B: GSO. 2020. Agriculture, Forestry and Fishery. In: *GSO*. Hanoi. Cited 20 September 2021. www.gso.gov.vn/en/agriculture-forestry-and-fishery

This achievement is a direct result of Viet Nam's political commitment to halt deforestation. In the mid-1990s, the country took even more serious steps towards improved forest management. The government adopted a multi-sectoral approach to gradually transfer its previously exclusive forest land rights to other actors, including non-governmental organizations (NGOs), local communities, businesses, management groups and individual households. This change in forest management was followed by a wide range of initiatives and interventions, including forest protection policies for the abandonment of swidden cultivation in upland fields, national reforestation programmes, among which the 5-Million-Hectare Reforestation Programme (5MHRP), implemented between 1998 and 2010, and facilitation of plantation establishments (Cochard *et al.*, 2020). The Viet Nam Forestry Development Strategy (FDS) 2006–2020 signed in 2007 set the forest cover targets to 47 percent to be reached by 2020 (Trieu *et al.*, 2020; Smith *et al.*, 2017).

The national policymakers continue to acknowledge the essential role of forests as a key source of livelihood for smallholder farmers, as a cornerstone element to mitigate soil erosion, and as an important factor for the conservation of biodiversity. Since 2016, the government has issued several other key policies to strengthen forest management and protection (see Box 3), as well as measures to improve incomes and financial support for households and individuals bearing forest management responsibilities.

Viet Nam has also been benefiting from international support to restore the forests. The country was selected as one of the first REDD+ pilot countries in 2008, and currently, Viet Nam is one of the few countries in the world implementing, contemporaneously, REDD+ Readiness, Forest Law Enforcement, Governance and Trade (FLEGT) Voluntary Partnership Agreement, and payments for ecosystem services (PES). More recently, Viet Nam has been targeted by several reforestation and greenhouse gas (GHG) emissions reduction projects supported by, among others, the United Nations, and the Forest Carbon Partnership Facility.

BOX 3 Recent forest policies in Viet Nam (2015–2020)

The Forestry Law, issued in 2017 and replacing the former Forest Protection and Development Law of 2004, provides a wider scope of regulations on the development, management, protection, and exploitation of forests. Some of the important changes include the specification of the forms of forest ownership, the promotion of forest product processing and trade, and the terms and conditions of land lease to foreign-invested companies to plant production forests.

The Directive 13–CT/TW of 2017 of the Party Central Secretary Committee on strengthening the management, protection, and development of the forests, and the Government's Resolution No. 71 / NQ-CP on the Action Plan to implement Directive 13, forbid People's Committees of provinces and cities from converting existing natural forest to other usages, with the exception of projects of national importance, such as serving national defence and security or necessary socioeconomic development, as approved by the Prime Minister.

Regarding forest development, the Decree No. 75/2015/ND–CP of 2015 sets out the mechanism and policy on financial support for the period from 2015–2020 to ethnic minorities, poor households, and local communities living in the mountainous areas and bearing forest management and development responsibilities.

The Decision No. 38-QD-TTg8 of 2016 also sets the target of planting 900 000 ha of planted forest, 75 000 ha of protection and special-use forest and regenerating 360 000 ha of forests by 2020. At the same time, it aims to improve livelihoods for households in mountainous areas.

Sources: MARD. 2018b. *Law on Forestry. Key Contents.* Hanoi; Kissinger, G. 2020. Policy responses to direct and underlying drivers of deforestation: Examining rubber and coffee in the Central Highlands of Vietnam. *Forests*, 11: 733. https://doi.org/10.3390/f11070733; FAO field visit in 2020.

Despite these combined efforts, the pressure on forests continues and Viet Nam is observing an unintended change in the quality of its forest coverage, which may expose the country to several ecological threats if not tackled properly. While the area under newly planted forests[4] continues to increase, the natural forests[5] continue to disappear and degrade putting the sustainability and the survival of the country's ecological system at risk. With this, the reforestation success stories may conceal the threats to the remaining natural forests in Viet Nam.

Data on forest cover from FAO Global Forest Resource Assessment clearly show the increase in forest cover as mostly driven by planted forest (increase of 476 percent in the period 1990–2019), and this is also confirmed by national statistics from GSO (see Figure 5). While in the early 1990s these were made up of native species such as pines, they have been predominantly established as single tree plantations afterwards (e.g. acacia) (Cochard *et al.*, 2020).

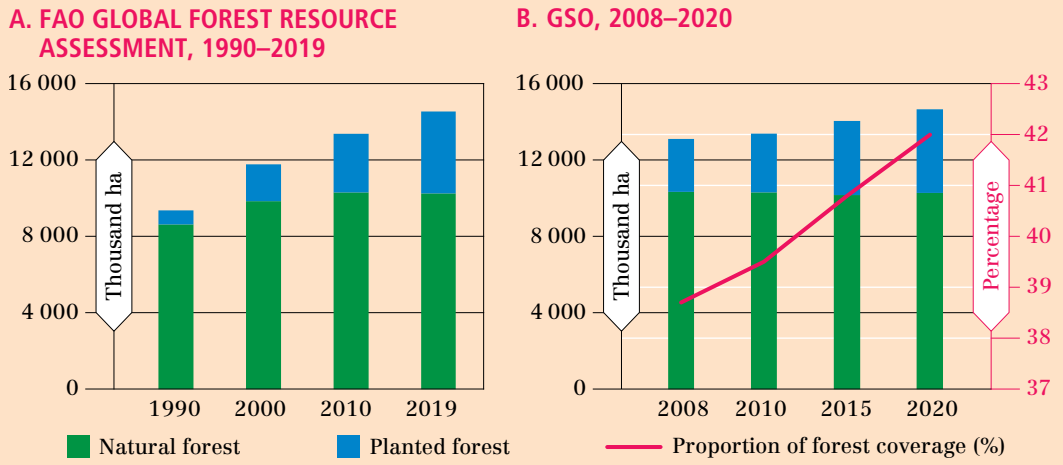
The area under naturally regenerating forest appears quite stable (see Figure 5), however, this trend does not reveal two important aspects. First, natural forests are continuously degrading. They are mostly composed of impoverished secondary forests of lower-quality tree species that have been re-growing spontaneously (Cochard *et al.*, 2020), while primary

[4] According to Circular No. 34/2009 / TT-BNNPTNT of 2009, defined as forests that are planted by humans, including new plantations on land without forests; replanted forests after timber harvest of existing planted forests, naturally regenerating forests from harvested planted forests.

[5] According to Circular No. 34/2009 / TT-BNNPTNT of 2009, defined as forests available in nature or by natural regeneration, and including primary and secondary forests.

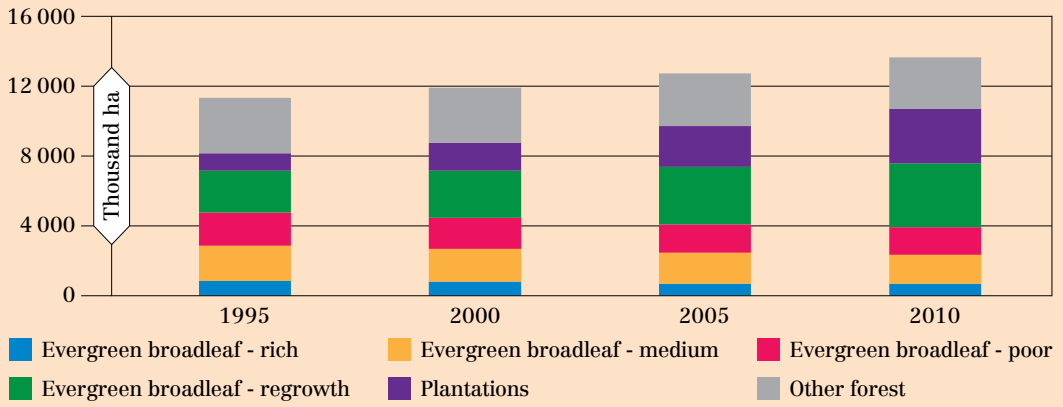
forests have almost disappeared – they currently make up only around 0.5 percent of total forests (FAO, 2020). Second, the overall flat trend of natural forests is a result of natural regrowth offsetting a small, yet persisting, decrease in natural forest. This is clearly shown in the disaggregation of forest cover into different forest types as categorized by the Ministry of Agriculture and Rural Development (MARD) for the period 1995–2010[6] (see Figure 6). Regeneration and regrowth of natural forests (evergreen broadleaf) increased by 52 percent over the period considered, while loss and degradation of natural forests continue to take place (-18 percent). Disaggregation of forest cover also confirms the largest contribution of plantation forests to the increase in forest cover, which virtually tripled in the period 1995–2010 from about one to three million ha.

FIGURE 5 Increase in forest cover driven by planted forest in Viet Nam



Sources: Panel A: FAO. 2020. *Global Forest Resource Assessment 2020.* Rome. Panel B: GSO. 2020. Agriculture, Forestry and Fishery. In: *GSO*. Hanoi. Cited 20 September 2021. www.gso.gov.vn/en/agriculture-forestry-and-fishery

FIGURE 6 Forest cover trends by forest type in Viet Nam, 1995–2010



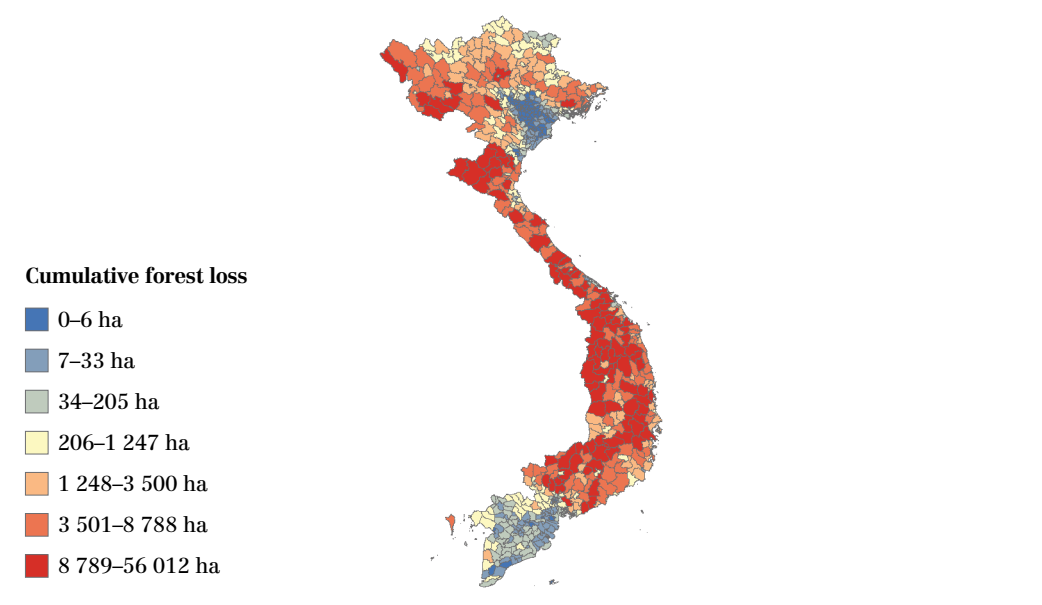
Note: 'Other forest' includes deciduous, bamboo, mixed woody–bamboo, coniferous, mixed broadleaf–coniferous, mangroves and limestone forests.

Source: MARD. 2016. *Viet Nam's Modified Submission on Reference Levels for REDD+ Results Based Payments under UNFCCC.* Hanoi.

[6] More recent data were unavailable.

An analysis of satellite data on tree cover loss from Global Forest Watch (GFW) platform (Hansen *et al.*, 2013)[7] for the period 2000–2016 shows that the tree cover loss has been more prominent in the central and northwestern areas of the country with losses ranging between 9 000 and 56 000 ha (see Figure 7). The areas around the main cities of Hanoi, Hai Phong, and Ho Chi Minh show almost no tree cover loss given that their high level of urban development has already limited the tree coverage in the neighbouring areas. These results, taken together with the trends observed in the country-wide statistics (see Figures 5 and 6), demonstrate there has been a continuous process of substitution of primary and other natural forests with planted forests.

FIGURE 7 Tree cover loss in mainland Viet Nam, 2000–2016



Source: Authors' elaboration based on Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O. & Townshend, J.R.G. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, 342(6160): 850–853. https://doi.org/10.1126/science.1244693

2.3 Channels of impact of agricultural sector development on forest cover loss

In Viet Nam, deforestation has been largely linked to agricultural sector development. According to the literature, it plays a key role in deforestation through several channels (Meyfroidt *et al.*, 2014; Richards, Walker and Arima, 2014), either directly through expansion of area devoted to agriculture, or indirectly through other drivers including infrastructure development, legal and illegal logging, and forest fires (see, among others, Pham *et al.*, 2012; Vu, Takeuchi and Van, 2014; Yang *et al.*, 2016; Pham *et al.*, 2019; Hosonuma *et al.*, 2012).

[7] The Global Forest Watch (Hansen *et al.*, 2013) dataset tracks "tree cover loss" as occurring, regardless of cause, when the percent of tree canopy cover falls below a specific threshold (e.g. 30 percent) at the scale of a Landsat satellite pixel (30*30 metres). "Tree cover" can refer to trees in plantations as well as natural forests, and "tree cover loss" is the removal of tree canopy due to human or natural causes, including fire. The data presented does not take tree restoration or regeneration into account and is therefore not an indication of net change. Focusing on tree cover loss within undisturbed primary forests, however, allows us to highlight some of the most critical forest areas where loss is likely to have long–term impacts.

At the global scale, the expansion of the agricultural land has directly contributed to deforestation of about 80 percent of forests (Kissinger, Herold and De Sy, 2012), and in Viet Nam, natural forest clearing led to almost doubling of the agricultural land in the period 1990–2018 (OECD, 2015). Commercial agriculture, mostly linked to the export market, was the main driver of deforestation in Viet Nam in the period 2005–2015 (Kissinger, 2020). The main commodities related to deforestation have been rubber, coffee and pepper, mostly driven by the high market prices, and cassava, easy to grow and considered as a transition crop before the establishment of tree crops such as coffee.

A major attributor to the expansion of agricultural land was through policies set up by the government surrounding the use of land. Despite the government's commitment to halt deforestation and forest degradation, and increase forest coverage, the land-related economic and policy issues continue to put pressure on the remaining natural forests (see Boxes 4 and 6 in Section 2.1).

Further, the expansion of agriculture has been accelerated by infrastructural developments. These, especially the construction of dams and roads, are considered a second major driver of deforestation in Viet Nam (FAO, 2017). The construction of dams may induce a further expansion of the agricultural land by farmers residing in the surrounding areas to benefit from increased irrigation opportunities, thus increasing local deforestation pressures. Construction of roads often requires clearing of forests, but at the same time induces the development of agricultural activities by connecting farmers to markets that may lead to further deforestation (Leinenkugel, Kuenzer and Oppelt, 2014; Rowcroft, 2008).

Logging also assumes an important role in deforestation in Viet Nam as the internal demand for timber products is on the rise. This represents a good source of additional income for smallholder farmers and can further contribute to deforestation. The volume of wood produced in Viet Nam increased fivefold in the period 1999–2016, from about two million m^2 in 1999 to more than 10 million m^2 in 2016 (Pham *et al.*, 2019), delivered by public state enterprises, private enterprises, and foreign investment entities. Logging-induced deforestation (both legal and illegal) from the private sector is particularly escalating due to their sharp upsurge in wood production (Pham *et al.*, 2019). The Vietnamese government has been striving to tackle the illegal logging and trade of wood, including the ratification of a voluntary partnership agreement with the Lao People's Democratic Republic and Cambodia. However, illegal logging, particularly in high-quality forests, and other associated activities leading to forest degradation remain a crucial problem for forest conservation (Cochard *et al.*, 2016; Saunders, 2014).

Expansion of agricultural activities is also linked to an increase in forest fires, whether accidental or human-induced. Fires continue to be one of the principal causes of forest degradation and, to a lower extent, deforestation. In the period 2002–2010, Viet Nam has experienced a yearly average of 704 forest fires, which have burned about 5 000 ha of forest each year (Pham *et al.*, 2012). Most of the accidental fires appear to develop in the production forests, during the period of harvesting of non-timber products, such as honey (CIFOR, 2019). Among the human-induced fires, a large portion is a result of farmers' slash-and-burn practices (61 percent), followed by hunting, wood and honey collecting practices (18 percent; MARD, 2010; Pham *et al.*, 2012). Information collected during the fieldwork reveals that recently, human-induced fires on both protected natural and planted forests to convert forests into acacia plantations have become more frequent and widespread. Intentional forest fires to acquire land for acacia planting have been identified as one of the main challenges in recent years and will continue to require stronger efforts from the government and local actors to halt it in the years to come.

Weak governance and inadequate land administration create further barriers to decreasing deforestation levels, especially the recognition of local rights to forest management

(Pham *et al.*, 2012; Van Khuc *et al.*, 2018; Do, 2015). Despite continued measures toward the decentralization of forest management, some authors highlight that local communities are still excluded from important decision-making processes (Do, 2015). Finally, the government of Viet Nam suggests that deforestation is conjointly a result of weak monitoring and evaluation capacities of local administrations and can intensify with increased conflicts amongst neighbouring communities (Tan and Hung, 2016; FAO, 2019).

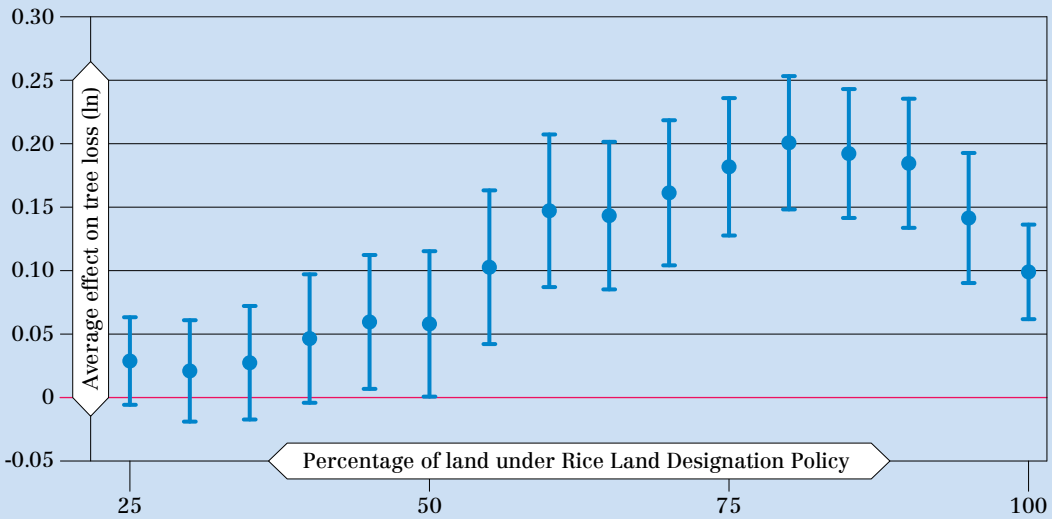
BOX 4 Agricultural land-use constraints increase agriculture-driven pressure on forests

Agricultural land expansion is a major driver of deforestation in many countries and land use policies play a key role in this process. Regulations governing land access, use and tenure, determine the range of farmers' production choices and influence agricultural productivity and sustainability. Restrictive land policies often have negative effects on farm incomes and lead to the adoption of coping strategies such as illegal deforestation to acquire additional land for production.

An analysis using a combination of geo-spatialized tree loss data, Viet Nam agro-census and data on land under Rice Land Designation Policy (RLDP), demonstrates that the expansion of agricultural land in areas where land-use constraints are enforced intensifies the average level of induced deforestation. The communes with more land under RLDP face higher levels of land expansion, of which about a fifth comes at the cost of forests. Tree loss intensity is highest when around 80 percent of land in the commune is designated to rice (see Figure 8). In communes where land-use restrictions are not binding, the effect is negligible.

As a result, the agricultural land scarcity and the land-use restrictions may push farmers to cultivate in the non-designated areas, putting pressure on forests.

FIGURE 8 Cropland expansion effect on tree loss intensifies with more prominent land-use constraints



Source: FAO. 2021. *Reducing agriculture-led forest loss in Viet Nam: the role of land use constraints.* FAO Agricultural Development Economics Policy Brief 35. Rome. www.fao.org/3/cb3651en/cb3651en.pdf

3 Evolving trends in agriculture sector development and consequences for deforestation

KEY MESSAGES

- As land constraints become increasingly binding, Viet Nam recognizes that future growth in the agricultural sector must come from enhancing value-added of agricultural products.
- Vietnamese diets are shifting towards greater consumption of animal products, fruits and vegetables, and processed food, as a result of raising incomes, population growth and urbanization.
- The government is promoting the domestic production of these commodities through several policies, with the aim of reducing the production gap and restructure production systems.
- However, there is an inherent risk that supporting domestic production of livestock products becomes once again a primary driver of deforestation if future developments do not consider sustainable use of land.

3.1 The prospective shift of the agricultural sector: towards increasing value added

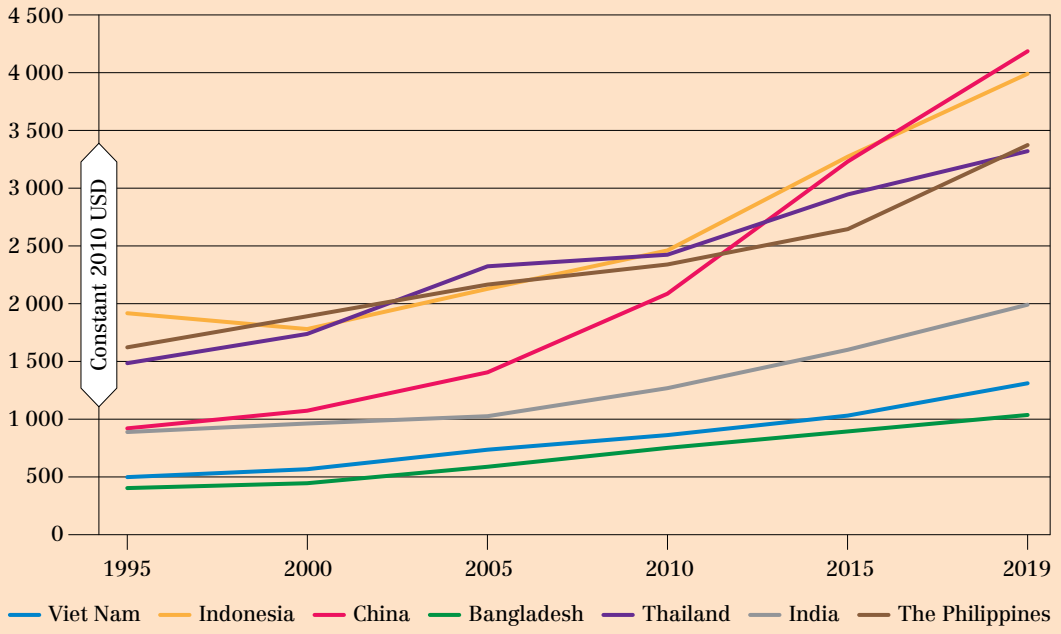
Viet Nam has recognized that the progress of the agricultural sector achieved so far, although key for the country's socioeconomic growth, has not allowed the country to harness all potential benefits associated with the agricultural development. Agricultural value-added per worker has remained very low, compared to regional peers' performance (see Figure 9). Sectoral growth patterns have been characterized by high resource-intensity, in the use of agricultural land as well as of labour and water and prevented the country from gaining efficiency (World Bank, 2016).

Given the crucial role that agriculture still plays in Viet Nam's economy and the limited scope as well as the unsustainability of continuous expansion of agricultural land, Viet Nam recognizes that future growth in the agricultural sector must come from increasing value-added.

The Agriculture Restructuring Plan signed by the Prime Minister in 2014, which defines and embeds agricultural sector goals within the sustainable development approach for example, aligning it towards economic, social and environmental sustainability, clearly shows the prospective shift in the strategy of Viet Nam's agricultural sector. Future growth will stem from enhancing farm productivity and production efficiency, improving product

quality and safety, expanding crop diversification, and developing post-harvest stages of commodities' value chains (World Bank, 2016; JICA, 2013; IPSARD, 2020; OECD, 2019, 2020). Mechanization and innovation, and sustainable intensification can support agricultural growth without the need to convert more land. Increasing value-added in agricultural export-oriented products and promoting the production of high-value import-competing commodities could allow the country to earn more foreign exchange, increase farm incomes and benefit other actors along the commodity value chains.

FIGURE 9 Agricultural value-added per worker



Source: World Bank. 2020. *World Development Indicators*. Washington, DC. Cited 5 December 2021. https://databank.worldbank.org/source/world-development-indicators

The key commodities-drivers of this shift will mostly include animal products (i.e. meat and dairy, fruits and vegetables and processed food). Their consumption has been boosted recently due to changing diets of the population, following rising disposable incomes, urbanization, and population growth (Dung *et al.*, 2019; World Bank, 2017). Internal production is lagging behind (with different trends depending on the sector), to some extent complemented by imports to satisfy growing internal demand (Annex 4 summarizes production and consumption trends of meat and dairy sectors, and trade patterns).

Due to their great potential in increasing agricultural value-added, the high demand and new market opportunities, these commodities are also increasingly promoted by the government. With respect to livestock, the government is playing a crucial role in developing and expanding production, backstopping it with a set of policies[8] including regulations to restructure the livestock sector and increase its productivity through innovative

[8] Some policies were crucial for the restructuration of the livestock sector: in 2008, Decision No. 10 – Animal Breeding, provides the livestock strategy by 2020, mainly involving a switch to commercial production to meet domestic and export demand, the industrialization of about 50 percent of feed production, release of land to commercial farms and improvements of value chains; in 2013, Decision No. 899 – Agricultural Sector Restructuring Project, promoting industrialization, intensification and relocation of the livestock sector out of urban centres; in 2014, Decision No. 984 – Livestock Restructuration Policy of the Ministry of Agriculture and Rural Development (MARD) includes the gradual relocation of large commercial livestock farms to areas less densely populated, and creation of 'Livestock Production Zones'.

production systems, and border protection, which was only recently relaxed. Further, to promptly respond to surging internal demand and to reduce the dependence on imports, the government strongly promotes the establishment of private large commercial farms (defined as *trang trai* in Vietnamese) in the livestock sector (Cesaro, Duteurtre and Nguyen, 2019). Incentives to commercial livestock farmers include simplified access to land lots, more funding opportunities, easier access to credit, or state grants. As a result of these policy incentives,[9] smallholder farming, until now the most widespread production system in Viet Nam, has been increasingly complemented by commercial farming in the last decades, delineating a dual production system.

3.2 Is there a related deforestation risk?

Despite the likely positive impact on the economy, the prospective shift of Viet Nam's agricultural sector in developing and expanding selected sectors (e.g. horticulture, meat and dairy sectors) to improve value-addition should also raise caution.

As demand for additional land remains strong, it is crucial that any developments in these agrifood value chains effectively meet the objectives of increased value added without contributing to further agricultural land expansion that would likely come through deforestation. In particular, the livestock sector is a leading cause of deforestation globally, either directly, for example, through pasture expansion for beef production, or indirectly through expansion of intensive large-scale cultivations of feed crops including soy and maize (FAO, 2006).

Evaluating the extent to which different commodities have been contributing to deforestation in Viet Nam would allow policymakers to better understand any potential deforestation risk embedded within these sectors. However, this is not easy to evaluate, mainly due to a lack of comprehensive geo-spatial data on the proportion of deforestation attributable to specific agricultural commodities.

Recent studies have attempted to estimate and attribute the role that particular commodity plays in deforestation. Pendrill *et al.* (2019b) estimate the extent to which all the major commodities, including rubber plantations, beef, oil palm, soy, rice, coffee, tea, cassava, etc., have replaced forests using the best available spatially explicit data. While these numbers are only indicative,[10] they provide useful insights into the levels of deforestation risks associated with each agricultural commodity and how these deforestation risk levels have been evolving over time. As per their updated dataset (Pendrill, Persson and Kastner, 2020),[11] 19 percent of forest loss between 2005–2017 could be attributed to the expansion of rubber plantations, a further 19 percent to vegetable production and 12 percent of forest loss could be attributed to the expansion of rice production, and finally, almost 8 percent of forest loss between 2005–2017 could be attributed to beef production. Focusing on the yearly contribution of these major commodities to deforestation in Viet Nam in 2005, 2010, 2015 and 2017 (see Table 1 and Figure 10), demonstrates that higher-value commodities such as vegetables and beef are increasingly linked to deforestation, while more traditional commodities including rice, maize and cassava are reducing their contribution.

[9] Despite relaxing border protection measures, beef still benefits from producer price protection policies which increase the domestic producer prices above international market prices albeit to a lower extent. According to the OECD Producer and Consumer Support Estimates database 2020, in the period 2017–2019 beef producers were receiving prices 13 percent higher than world market prices.

[10] The methodological approach used in Pendrill *et al.* (2019a and b) and Pendrill, Persson and Kastner (2020) may be debatable due to its simplicity.

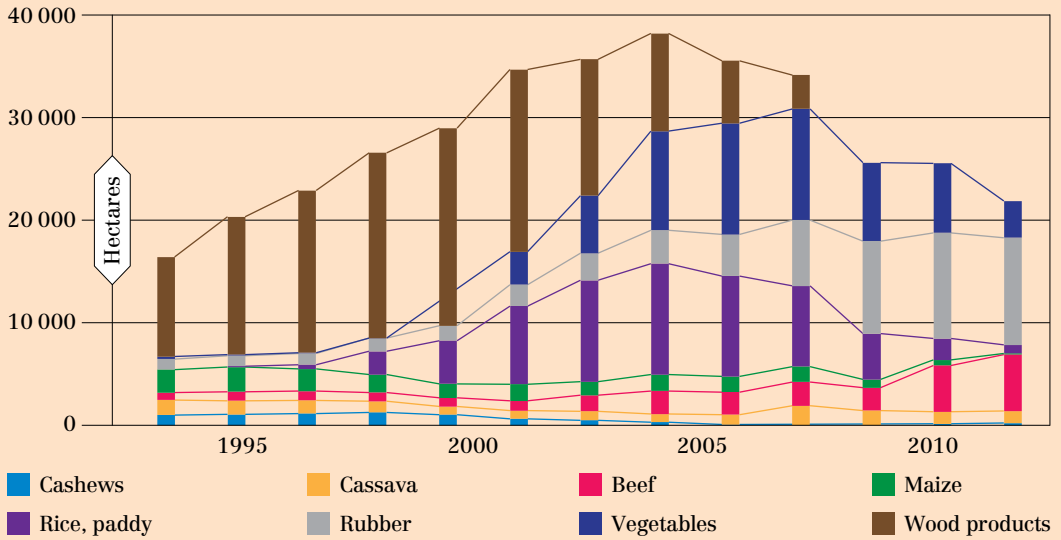
[11] The database removes Viet Nam's plantation harvests whenever possible. This increases the reliability of the resulting estimates.

TABLE 1 Yearly contributions of selected commodities to deforestation in Viet Nam, 2005–2017

	2005	2010	2015	2017
Wood products	51.9%	44.8%	–	–
Rice, paddy	–	19.2%	11.0%	1.7%
Maize	12.0%	4.1%	2.0%	0.2%
Cassava	7.8%	2.0%	3.6%	2.4%
Cashew	5.4%	1.6%	0.0%	0.5%
Rubber	5.4%	5.3%	22.3%	21.5%
Beef	3.9%	2.4%	5.5%	11.3%
Vegetables	1.3%	8.1%	18.9%	7.3%

Source: Pendrill, F., Persson, M. & Kastner, T. 2020. *Deforestation risk embodied in production and consumption of agricultural and forestry commodities 2005-2017*. Chalmers University of Technology, Senckenberg Society for Nature Research and Ceres Inc. https://doi.org/10.5281/zenodo.4250532

FIGURE 10 Yearly contributions of selected commodities to deforestation in Viet Nam, 2005–2017



Source: Pendrill, F., Persson, M. & Kastner, T. 2020. *Deforestation risk embodied in production and consumption of agricultural and forestry commodities 2005-2017*. Chalmers University of Technology, Senckenberg Society for Nature Research and Ceres Inc. https://doi.org/10.5281/zenodo.4250532

The extent to which further developments in high-value commodities will be associated with additional deforestation, maintaining or accelerating the trends reported by Pendrill, Persson and Kastner (2020), will be related to the evolution of the demand for additional land. The land demand is a simultaneous result of many factors, including general production patterns, consumption trends, policy incentives, and competing demand for land from different sectors. As currently the demand for additional land remains strong, it is key to ensure that developments in the targeted agrifood value chains, particularly beef and dairy, are framed by adequate policies and investments that effectively meet the objectives of increased value-added without contributing to further agricultural land expansion.

4 An overview of dairy and beef sectors in Viet Nam

KEY MESSAGES

- The recent rapid surge in dairy domestic demand has been largely fulfilled by internal production, to a lower extent by imports. Future projections highlight the trends will continue.
- Strong government promotion of internal production favoured the creation of innovative large dairy companies.
- Beef consumption surge in recent years created a widening production gap, fulfilled by imports, as the traditional system is not structurally able to keep up with the demand and only partially absorbs government support.
- As imports are key for the higher quality market segment, the beef sector will likely see a parallel expansion of both imports and domestic production, with the latter likely increasing the demand for new agricultural land (e.g. for pasture expansion, construction of buildings and related infrastructures, and to grow animal feed).

This section briefly introduces the current trends and patterns of dairy and beef production and consumption and highlights how the two sectors may substantially contribute to agricultural land expansion, now and in the near future.

4.1 Dairy sector: very recent development marked by large dairy companies

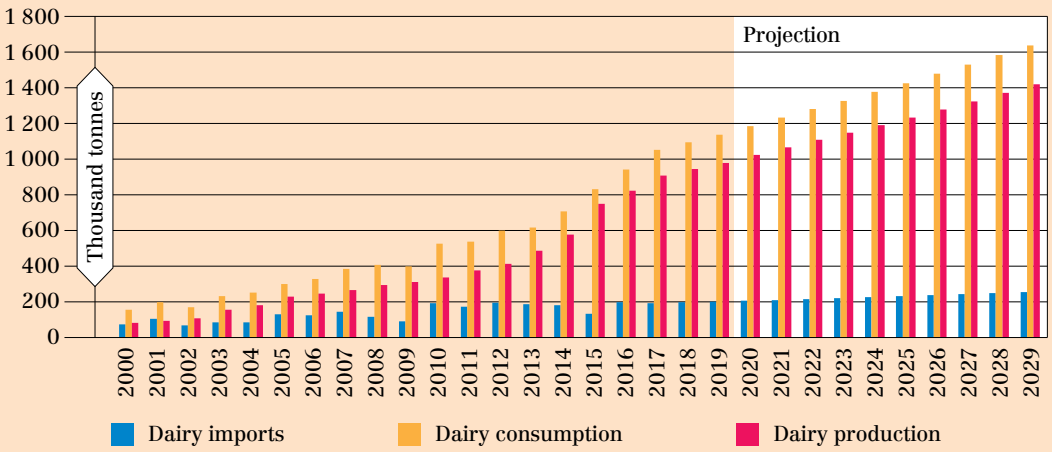
Historically, Viet Nam has not shown deep traditions in developing the dairy sector, and cattle were generally kept as a safety net for difficult periods as a source of additional revenue or food (FAO, 2008). The first dairy farms were established during the collectivization period (1970s–1980s) in the North Central region, in the form of large state-owned enterprises. The *Đổi Mới* reforms in the 1980s were pivotal for dairy development, privatizing the production and prioritizing small-scale farmers (Pham, 2016). The National Dairy Development Plan (NDDP) and the Government Decision No. 187 of 2001 strongly encouraged dairy farming enabling provincial authorities to provide support and setting production targets to be reached by 2010 (Pham, 2016). These were aimed at meeting about 40 percent of internal demand, reducing import dependence and saving foreign exchange. In these years, as demand for dairy products was persistently growing since the 1990s, imports also surged. In 2008, the National Livestock Development Strategy, with objectives until 2020, shifted the priority from small to large-scale production, leading to the establishment of large dairy companies. Accordingly, in recent years, a couple of huge innovative dairy companies emerged in Viet Nam, significantly marking the profile of the current dairy sector.

The change in demand and consumer preference among the population, including the integration of more milk and dairy products in their diets, has pushed the dairy sector to grow in the 1990s and it has been in continuous expansion since then. Since the early 2000s, dairy consumption[12] has grown at an average rate of 11 percent per year, and it is projected to increase by 4 percent per year on average until 2029 (see Figure 11). According to the Viet Nam Dairy Association, the average dairy consumption per capita in Viet Nam is 28 litres per year, which is still well below the global average, or neighbour countries like Thailand (108 and 35 litres per capita, respectively), suggesting that there is much more room for demand to increase in the coming years.

Mirroring the boost in consumption, both dairy cow heads and fresh dairy production[13] substantially increased and are expected to further expand by 4 percent per year by 2029 (see Figure 11). In line with dairy policies, the increase observed until 2010 was driven by small dairy farmers, while the expansion in the following period came through setting up large-scale farms. The domestic supply of dairy products does not keep up with growing internal demand, thus, a consistent share of milk is imported. A limited share of Vietnamese dairy products is exported (Annex 4 provides more detailed trade information).

Predictions for the dairy sector (see Figure 11) indicate that future demand will likely pour on domestic production, rather than on imports, mirroring the recent past trends, in which the rapid increase in consumption has been followed by a rapid increase in production (while the increase in imports has been relatively marginal). These trends may in part be explained by the peculiar characteristics of the dairy sector, especially the perishability of the fresh product, which makes it lowly compatible with large operations in terms of import and export. For this reason, the level of dairy imports and exports remains limited and respectively equal to about 21 and 2 percent of the total internal production (OECD and FAO, 2020).

FIGURE 11 Dairy production, consumption and imports in Viet Nam, 2000–2019 and 2029 projections



Source: OECD & FAO. 2020. *Agricultural Outlook 2020–2029*. Paris, OECD Publishing and Rome, FAO. Cited 21 September 2021. https://doi.org/10.1787/1112c23b-en

[12] According to OECD–FAO Agricultural Outlook 2020, in the last decade (2009–2019), consumption of fresh dairy products expanded from 311 000 to 981 000 tonnes, expected to further grow up to 1 422 000 tonnes by 2029. Consumption of milk powder reached 131 000 tonnes in 2019, and according to projections it will reach 180 000 tonnes in 2029. Consumption of cheese and butter respectively amounted to 16 and 9 000 tonnes in 2019, and it is expected to slightly increase by 2029.

[13] Domestic production is mostly focused on fresh products, while it mainly relies on imports for products such as milk powder, butter and cheese.

In this context, national companies facing an increased internal demand will try to meet it by increasing their level of production more and more. While this can derive from the direct expansion of companies' production, it may also occur through contracting with other farmers for partial production outsourcing, as it may be easier to overcome potential land constraints.[14] This will likely involve the acquisition of new agricultural land, especially in relation to feed crop cultivation.

4.2 Beef sector: a long-standing tradition for low-value market segment

Contrarily to the relatively new dairy sector, Viet Nam has a long-standing tradition in beef cow rearing, with the predominance of smallholder farming as a production system. Still, in 2020, 80 percent of beef cows were raised by households (Viet Nam Ruminant Husbandry Association, 2020). Since 2015, few commercial beef-cow farms started to emerge in Viet Nam, as a result of government promotion of the livestock sector (mainly the National Livestock Development Strategy of 2008 and Decision No. 984 – Livestock Restructuration Policy of 2014, described in the previous section), especially in Ba Vi, Ha Tinh provinces and Central Highlands. Nevertheless, the 'livestock revolution' occurring in other livestock sectors following the government's efforts, seems only partially absorbed by the beef sector, which remains dominated by the traditional system and by conventional techniques. The production of beef will continue to have relatively lower productivity gains unless modernised.

Beef consumption, which pulled the beef sector to expand, started to grow in the early 2000s, and surged in the last decade (see Figure 12), growing by 10 percent per year on average. Per capita consumption surpassed the global average in 2012, and according to the OECD–FAO projections, in 2029 Viet Nam will consume about 33 percent more beef than the world average (9.6 versus 6.3 kilograms per capita respectively). In comparison with other countries, beef consumption per capita is, and will be, much closer to that of Australia, the United Kingdom of Great Britain and Northern Ireland and the United States of America, than to that of other regional peers including China, Indonesia, the Philippines and Thailand. In the same period, however, domestic production grew considerably less (by 4 percent per year on average) and was not able to keep up with internal demand (see Figure 12).[15] This created a substantial production gap, widening in the last few years, which is increasingly filled in by imports.

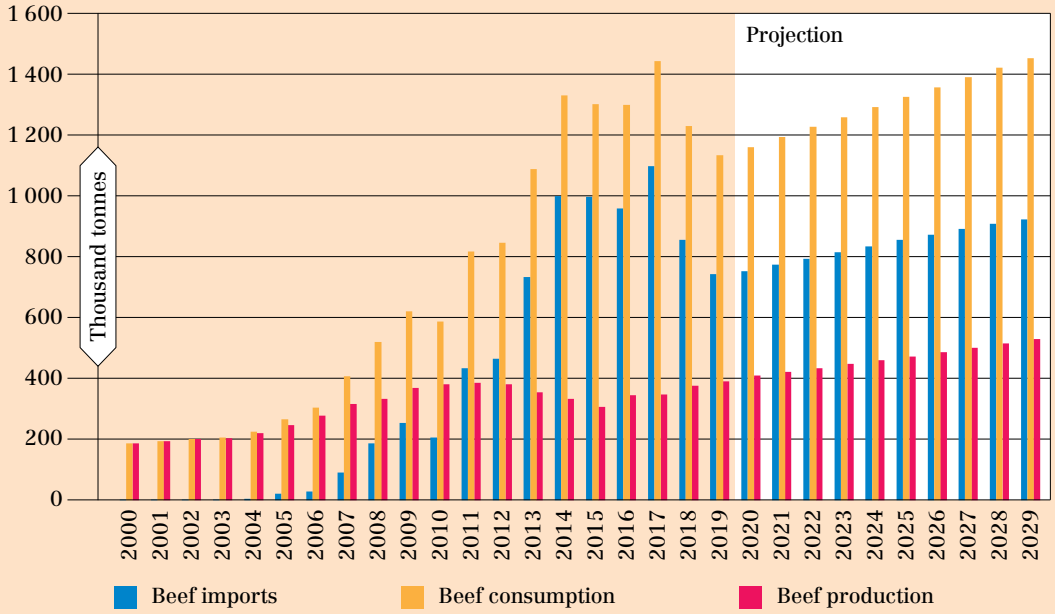
The prevalence of the smallholder farming system is likely one of the underlying factors that constrain beef production expansion and limit the sector's productivity. Moreover, there exists a structural difference between domestic production and imports in terms of quality and end-market – with the former being of low quality for local consumption, and the latter being of high quality mainly for supermarkets and restaurants – which underpins the great reliance on imports to complement internal production. Accordingly, future growth of the beef sector is expected to see a parallel expansion of both imports and domestic production, with the shares between imports and domestic production not expected to change in favour of the latter.

[14] Confirmed by the fieldwork in the case of Vinamilk company (see Section 5).

[15] Beef production had been overall increasing in the period 2000–2019, expanding from 186 000 to 392 000 tonnes. The highest increase occurred in the 2001–2011 period, with an average increase of 7 percent per year. A decline initiated afterwards, following a period of reduced grazing land due to revisions in the Land Law. After 2016, production recovered and it is projected to grow by 2.9 percent per year until 2029, reaching 531 000 tonnes (OECD–FAO, 2020). Compared to other types of meat, beef is the third in terms of quantity produced after pork and poultry. Its share in overall meat production has been stable at around 8 percent and is forecasted to remain at this level (see Annex 4).

The expansion of domestic production would imply an expansion of the traditional system, with related efficiency and productivity issues. Moreover, as the traditional system continues to prevail, it is likely to increase the demand for additional land.

FIGURE 12 Beef consumption, production and imports in Viet Nam, 2000–2019 and 2029 projections



Source: OECD & FAO. 2020. *Agricultural Outlook 2020–2029*. Paris, OECD Publishing and Rome, FAO. Cited 21 September 2021. https://doi.org/10.1787/1112c23b-en

5 Exploring potential links between dairy and beef and deforestation: the case study of cow rearing in Nghe An and Ha Tinh provinces

KEY MESSAGES

- The empirical analysis shows that cow rearing is positively and significantly correlated with tree cover loss, largely driven by households specialized in cow rearing, and highlights the presence of positive spatial correlation between the two in nearby communes.
- The dairy value chain consists of vertically integrated large dairy companies, which ensure efficient and productive value chain operations, and high-quality products. Yet, they entail huge feed requirements that create favourable conditions for increased feed crop cultivation (maize and grass) and may require substantial infrastructural work (e.g. roads, hydropower plant construction).
- The beef value chain involves mainly small family producers and primary raw beef processing, though some limited transition towards intensification seems to be taking place. It is rather inefficient with low productivity and profitability.
- Beef and dairy sectors are linked to deforestation through increased demand for land from the direct need to establish or expand existing farms and related infrastructure, and indirectly from the growing demand for feed. The demand for land is likely to continue growing if no action is taken, increasing the risks of deforestation.

Strong government promotion, boosting consumption levels, and clear land requirements, combined with the current land scarcity in Viet Nam, make the beef and dairy induced deforestation risk quite real. Even though dairy and beef sectors are not considered as primary deforestation drivers, they will likely play a key role in the future, if no action is taken. The increase in beef and dairy production will likely require additional land due to both the small size of available grasslands in the country as well as the structural characteristics of the sectors, and in the absence of strategic policies, it increases the risk of deforestation and degradation as land constraints (both availability and use) become increasingly binding.

This chapter aims to explore in detail the relationship between dairy and beef production and deforestation within two provinces in Viet Nam, namely Nghe An and Ha Tinh. The goal of this chapter is to provide insights on the relationship between beef and dairy production and deforestation, and to identify entry points for adequate policies and investments to reduce risk of deforestation induced by the production of these two commodities.

Nghe An and Ha Tinh were selected for the case study as they are two of the main priority provinces for beef and dairy sector development in Viet Nam. They are located in the North Central and Central Coast region, which holds more than 40 percent of the total country's cattle. Specifically, Nghe An ranks first among all the provinces in terms of cattle population, while Ha Tinh ranks ninth, and they respectively account for 8 and 3 percent of the total cattle heads nationwide. Both provinces have a considerable amount of forest cover, in particular natural forests, with several protected areas and most of the country's remaining primary forests.

The analysis is conducted using a holistic mixed-method approach that combines a descriptive analysis providing an overview of the agriculture sector, cow rearing for beef and dairy and forest cover trends in the provinces; empirical analysis of the correlation between cow rearing and tree cover loss at the commune level; and a value chain analysis of dairy and beef sector in the selected provinces to unpack the potential channels of impact.

Data covers a period up to 2016, the most recent period for which agricultural census data were available.

BOX 5 About Nghe An and Ha Tinh

With an area of 16 490 km², Nghe An is Viet Nam's largest province by area. It consists of one city, Vinh, and is further subdivided into three towns (Cửa Lò, Thái Hòa, Hoàng Mai), 17 districts (Anh Sơn, Con Cuông, Diễn Châu, Đô Lương, Hưng Nguyên, Kỳ Sơn, Nam Đàn, Nghi Lộc, Nghĩa Đàn, Quế Phong, Quỳ Châu, Quỳ Hợp, Quỳnh Lưu, Tân Kỳ, Thanh Chương, Tương Dương, Yên Thành), 431 communes and 32 wards. Nghe An is the fourth most populated province in the country with a population of over 3 million people (about 3.2 million in 2018). It has a diversified topography, with a coastal plain, hilly and mountainous areas, the latter accounting for about 83 percent of the territory. It is located in a strategic position on the east-west economic corridor that connects Myanmar-Thailand-the Lao People's Democratic Republic-Viet Nam-South China Sea. The province continues to experience robust economic development in recent years with an average GDP growth rate of 10.5 percent per year (Nghe An People's Committee, 2020).

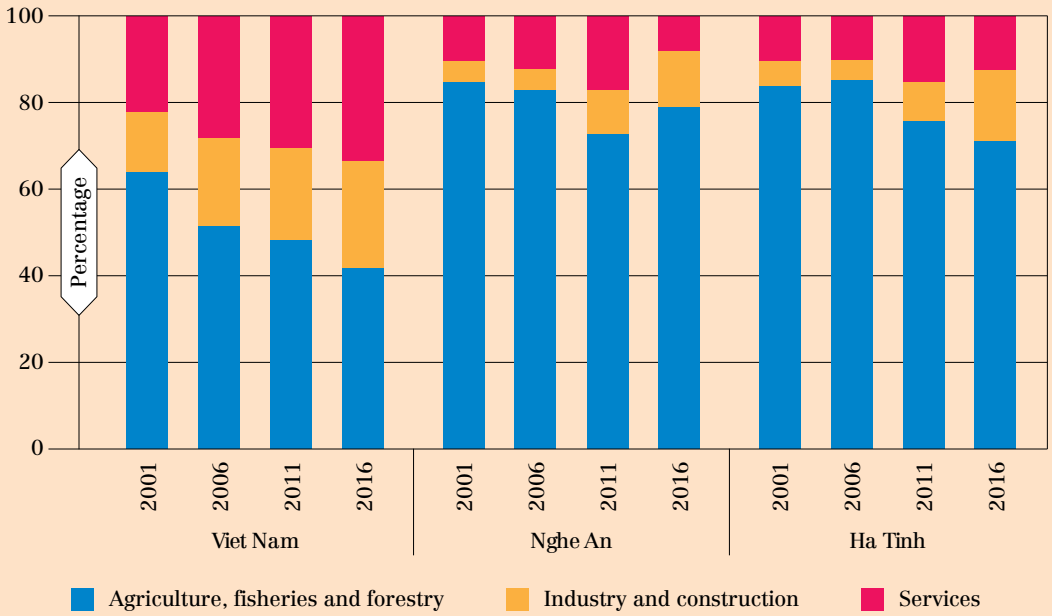
Ha Tinh is a comparably smaller province, with an area of 6 056 km² and consists of one city, Hà Tĩnh, two towns (Hồng Lĩnh and Kỳ Anh), 10 districts (Cẩm Xuyên, Can Lộc, Đức Thọ, Hương Khê, Hương Sơn, Kỳ Anh, Lộc Hà, Nghi Xuân, Thạch Hà, Vũ Quang), 235 communes, and 15 wards. It had a population of about 1.2 million in 2018. Ha Tinh borders Nghe An, Quang Binh, the Lao People's Democratic Republic, and the South China Sea. Similar to Nghe An, Ha Tinh's topography is diverse with mountains, midlands, plains and seas. From one of the poorest provinces in Viet Nam, Ha Tinh has achieved notable developments in recent years, and reached in 2019 a growth rate of nearly 11 percent (Ha Tinh People's Committee, 2019).

Sources: Ha Tinh People's Committee. 2020. *Forest resources and animals and plants*. Cited 5 October 2021. https://hatinh.gov.vn/vi/gioi-thieu/tin-bai/3001/tai-nguyen-rung-va-dong-thuc-vat; Nghe An People's Committee. 2020. *Introduction about Nghe An Province*. Vinh, Viet Nam. Cited 10 October 2021. http://nghean.gov.vn

5.1 State of agriculture and forests in Nghe An and Ha Tinh

In Nghe An and Ha Tinh, agriculture continues to be the main source of livelihood. In both provinces, about three-quarters of the respective labour force is employed in agriculture, much higher than the national average of 42 percent (see Figure 13).[16] Despite the fact that in recent years more households are shifting to industrial and service sector employment, agriculture still remains the main source of income for close to 50 percent of rural households, and the secondary one for the 26 percent (GSO, 2016). According to census data (RAFC), about two-thirds of rural households in Nghe An and Ha Tinh define themselves as "agricultural households" due to the nature of their livelihoods (GSO, 2016).

FIGURE 13 Employment structure in Viet Nam and Nghe An and Ha Tinh provinces, 2001–2016



Sources: GSO. 2016. *Rural, Agriculture and Fishery Census*. Hanoi; World Bank. 2020. *World Development Indicators*. Washington, DC. Cited 15 November 2021. https://databank.worldbank.org/source/world-development-indicators

The agricultural sector in the provinces expanded in recent years. In Nghe An, agriculture experienced an average annual growth of 4 percent in the period 2011–2016, and livestock contributed to most of the growth (Nghe An Statistics Office, 2020). The province's targets for 2030 set out in the provincial development plans[17] highlight a similar growth is desirable in the coming years. In Ha Tinh, the agriculture sector observed an average growth of 4 percent in 2016 (Ha Tinh Statistics Office, 2016). From 2011 to 2014, the sector grew by 6 percent per year on average (Ha Tinh People's Committee, 2015).

Agriculture growth was accompanied by expansion of agricultural land, especially towards more commercial crops. In Nghe An, land for agricultural production,[18] occupied 15.6 percent of total land in 2011, and 18.4 percent in 2016, increasing from 257 to 304 000 ha (47 000 ha or 18 percent; Nghe An Statistics Office, 2020). Perennial crop

16 The focus period is up to 2016 as more recent data at the province level was not available.

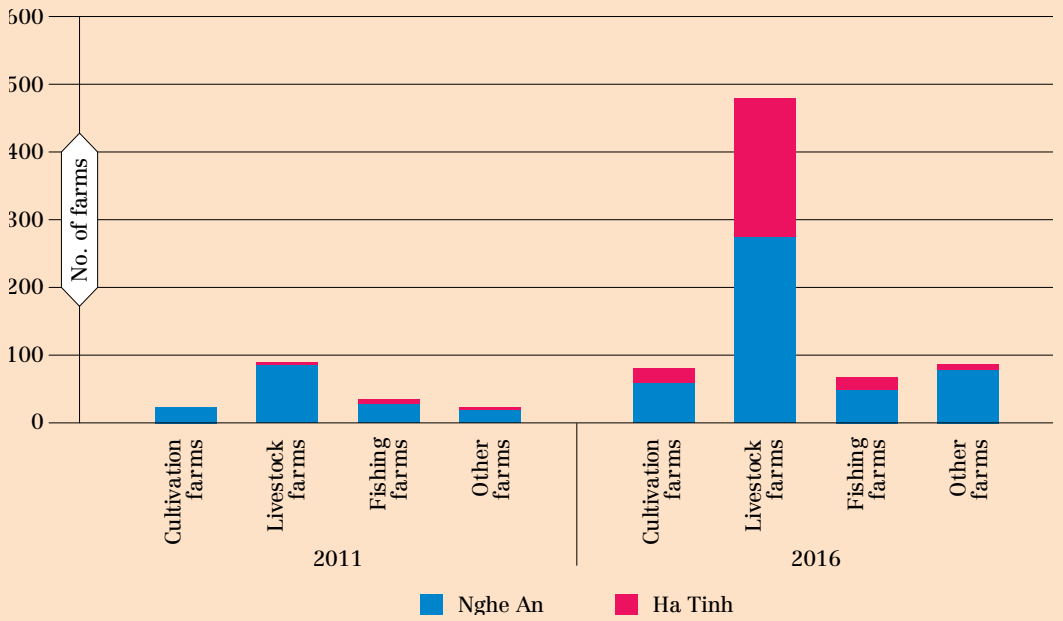
17 Resolution No. 168 of 2015 on the development plan until 2020 and vision to 2030.

18 Excluding forestry and fishery.

land mostly drove the increase (31 000 ha), with respect to annual cropland. This may indicate an initial shift towards more commercial crops, away from subsistence cultivation. The main cultivated crops[19] remain rice and maize, followed by sugar cane, cassava, tea and fruit crops. In Ha Tinh, agricultural land[20] occupied 27 percent of total land in 2016, or 160 000 ha (Ha Tinh Statistic Office, 2020). Perennial cropland expanded much in recent years (4 percent between 2015 and 2016). Paddy field area still occupies the largest area, and the other main crops[21] are peanuts, maize and fruits.

In line with the expansion of the agricultural sector, the number of farms within the provinces substantially expanded in recent years (from about 200 to 700), especially those in the livestock sector (see Figure 14).

FIGURE 14 Number of farms by activity, Nghe An and Ha Tinh, 2011 and 2016



Notes: "Other farms" include forestry and 'mixed' farms. The years 2011 and 2016 have been taken as reference to remain consistent with available data from the RAFC.

Source: GSO (General Statistics Office of Viet Nam). 2020. Agriculture, Forestry and Fishery. In: *GSO*. Hanoi. Cited 20 September 2021. www.gso.gov.vn/en/agriculture-forestry-and-fishery

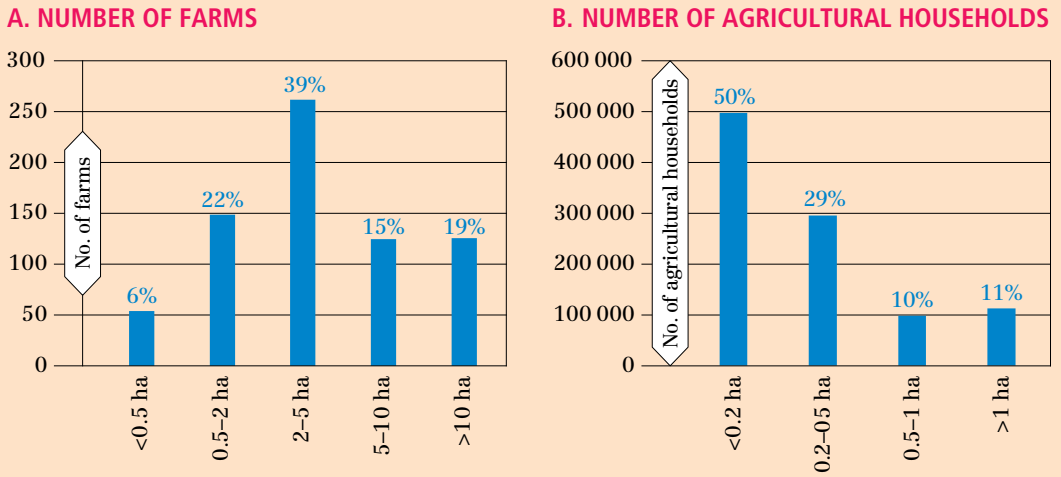
Land ownership is rather fragmented in the provinces. Most farms own 2–5 ha of land, and 67 percent own less than five ha, whereas only 19 percent own more than ten ha. The amount of land owned by rural households is also very limited and in line with national trends. The 50 percent of the rural population holds less than 0.2 ha, and 80 percent less than 0.5 ha (see Figure 15). Households with more than one hectare only constitute 11 percent of the rural population. Annex 5 expands on the profile of rural households derived from an analysis of rural census data (GSO, 2016).

19 In 2016, rice: 182 000 ha; maize: 59 000 ha; sugar cane: 23 000 ha; cassava: 19 000 ha; tea: 11 000 ha (GSO, 2020). In 2019, rice: 185 000 ha; maize: 48 000 ha; sugar cane: 25 000 ha; cassava: 15 000 ha; tea: 12 000 ha; fruit crops: 22 800 ha (Nghe An Statistics Office, 2020).

20 Excluding forestry and fishery.

21 In 2016, rice: 103 400 ha; maize: 9 600 ha (GSO, 2020). In 2019, rice: 103 500 ha; peanut: 12 300 ha; maize: 11 000 ha (Ha Tinh Statistics Office, 2020).

FIGURE 15 Number of farms and agricultural households by land owned, Nghe An and Ha Tinh, 2016



Source: GSO. 2020. Agriculture, Forestry and Fishery. In: *GSO*. Hanoi. Cited 20 September 2021. www.gso.gov.vn/en/agriculture-forestry-and-fishery

According to MARD (2018a), the expansion of agricultural land has been a key driver of deforestation in the North Central and Central Coast region, to which Nghe An and Ha Tinh belong. This involved forest clearing for the establishment of rubber and other tree plantations, mainly composed of fast-growing species such as acacia, which are easy to manage but inferior in terms of soil moisture retention and flood prevention, and bring about considerable biodiversity loss, as confirmed by local experts[22] during the field interviews (see Annex 7). Conversion of forest land for agricultural purposes is also linked to the production of crops such as cassava and maize. Yet, cassava, mostly produced by small farmers due to its relevance for starch and biofuel stock, is not considered to be a primary driver of deforestation in the future. Maize is planted by both companies and smallholders. Other small-scale conversion has occurred for production of other crops such as coffee, tea, and pepper. Encroachment by local communities converting forest into crop or tree plantation has a significant cumulative impact. Hydropower and transport infrastructure and illegal logging are also responsible for some deforestation in the region (MARD, 2018a). These factors have been widely acknowledged also by several stakeholders interviewed during FAO's field visit, spotted as relevant for the studied provinces as well (Box 6 and Annex 7 provide more details).

Nghe An and Ha Tinh observe a remarkable share of land under forest coverage. In 2016,[23] they were equal to 57 and 52.4 percent of their territory, respectively, much above the national average of 41.2 percent (GSO, 2020). More specifically, forest coverage in the two provinces consists of 989 000 and 326 000 ha, respectively, and represents about 42 percent of all forests in the North Central and Central Coast region.

In terms of spatial distribution, based on satellite data (Hansen *et al.*, 2013) for 2000[24] on actual tree cover, forests were concentrated in the rural areas of the provinces: in the

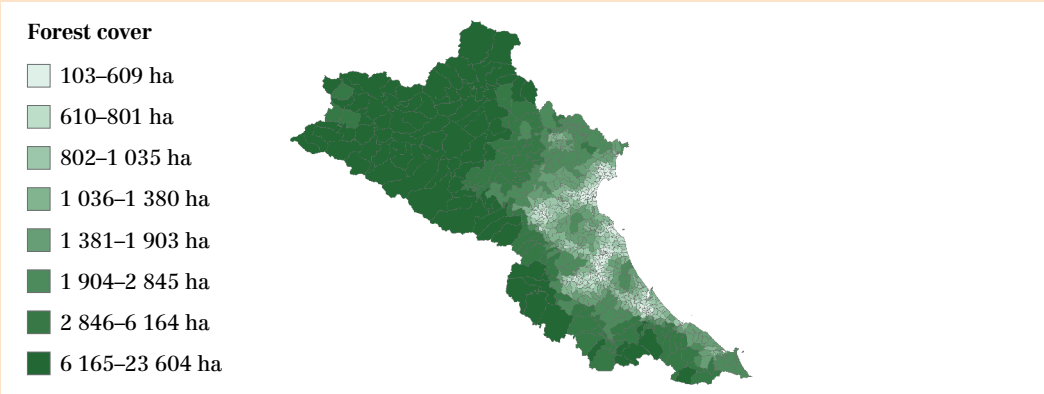
[22] Such as the Head of Tan Ky District Forest Protection Unit, the Deputy Director of Yen Thanh District Forest Protection Department, the Deputy Head of Nghe An Crop Cultivation and Plant Protection Department.

[23] Although more recent data are available, for sake of comparability with agricultural data available only 2016, forest cover numbers are reported for the same year.

[24] At the moment of drafting this report, processed satellite data on actual forest coverage for more recent years were not available.

northwest and west areas of Nghe An, and the west and southwest areas of Ha Tinh (see Figure 16). The level of tree coverage was limited in the areas close to the two major cities (Vinh and Ha Tinh). The spatial distribution has likely remained similar, yet the density and quality of tree coverage might have changed.

FIGURE 16 Hectares of tree cover area per commune, 2000

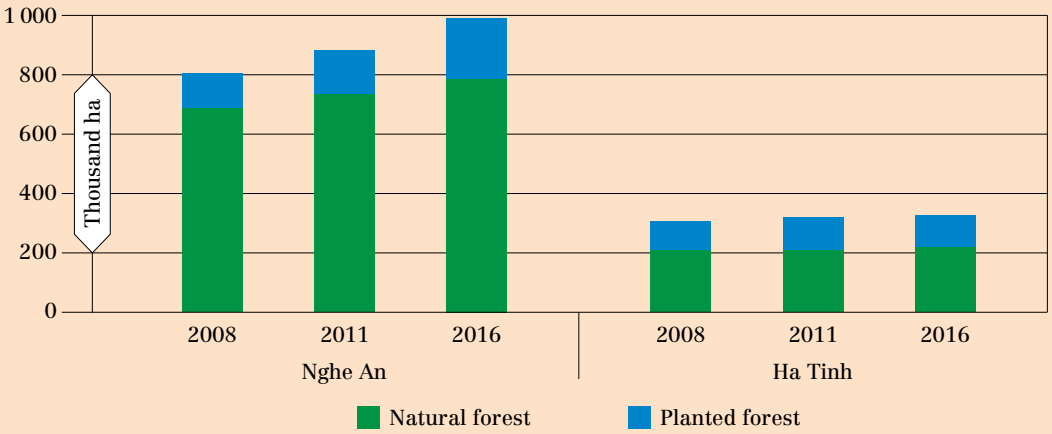


Note: More recent processed satellite data on actual tree cover were not available at the moment of drafting this study.

Source: Authors' elaboration based on Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O. & Townshend, J.R.G. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, 342(6160): 850–853. https://doi.org/10.1126/science.1244693

Total forest cover is showing an increasing trend (though small for Ha Tinh). However, studying the different forest types, it is possible to capture that this is mostly driven by planted forests (see Figure 17). In Nghe An, this increased by 70 percent from 2008 to 2016 (from 118 000 to 202 000 ha), while in Ha Tinh it expanded by 10 percent (from 98 000 to 107 000 ha). The spontaneous regeneration and regrowth of natural forests make the trend in natural forests slightly positive.

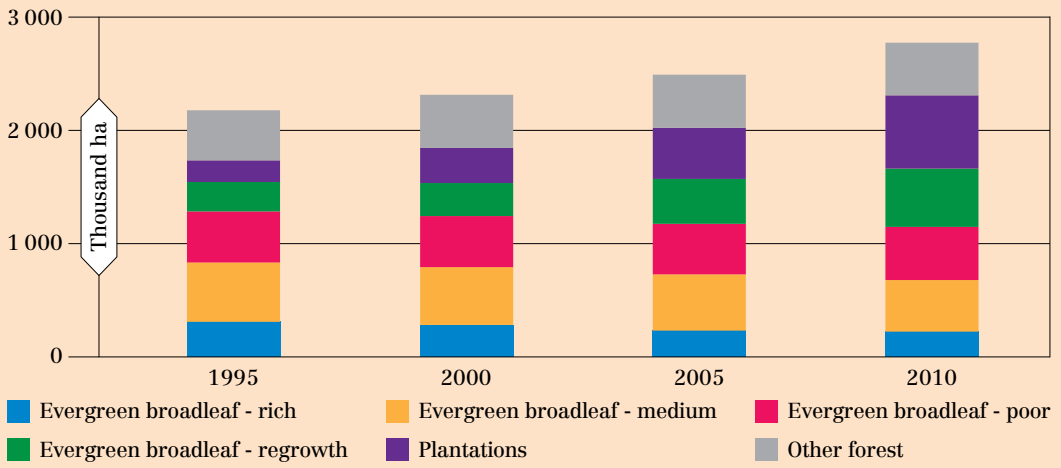
FIGURE 17 Forest cover in Nghe An and Ha Tinh, natural vs planted forest, 2008–2016



Source: GSO. 2020. Agriculture, Forestry and Fishery. In: *GSO*. Hanoi. Cited 20 September 2021. www.gso.gov.vn/en/agriculture-forestry-and-fishery

At the same time, however, the quality of natural forests is slowly decreasing and natural forests are gradually substituted with secondary forests. Additional data from the MARD show that some deforestation may be still taking place in the provinces, and that natural forests are being continuously degraded. Looking at the data for the North Central and Central Coast region,[25] overall forest cover has been increasing (+28 percent) since the mid-1990s. However, disaggregating this trend according to different forest types,[26] the increase was mostly the result of establishment of plantations (+232 percent) and natural regrowth (+100 percent), mirroring national trends (see Figure 18). The net increase in overall forest cover indeed hides some deforestation that is still occurring; evergreen broadleaf forests classified as 'rich' and 'medium' decreased by 27 and 18 percent respectively in the period 1995–2010.

FIGURE 18 Forest cover trends by forest type, Nghe An and Ha Tinh, 1995–2010



Source: MARD. 2016. *Viet Nam's Modified Submission on Reference Levels for REDD+ Results Based Payments under UNFCCC*. Hanoi.

An analysis of tree cover trends using satellite data from GFW platform (Hansen *et al.*, 2013), suggests that tree cover loss has been on the rise in both provinces. Forest cover loss data derived from Hansen *et al.* (2013) do not differentiate between deforestation in natural forests and plantation rotations, hence, they may provide an overestimated figure of deforestation. However, plantation harvests made up only 8 percent of all tropical tree cover loss from 2013 to 2019 (Harris, Goldman and Gibbes, 2019), and other time-varying geo-localized datasets on forest cover with disaggregation into forest types were not accessible when writing the study.[27]

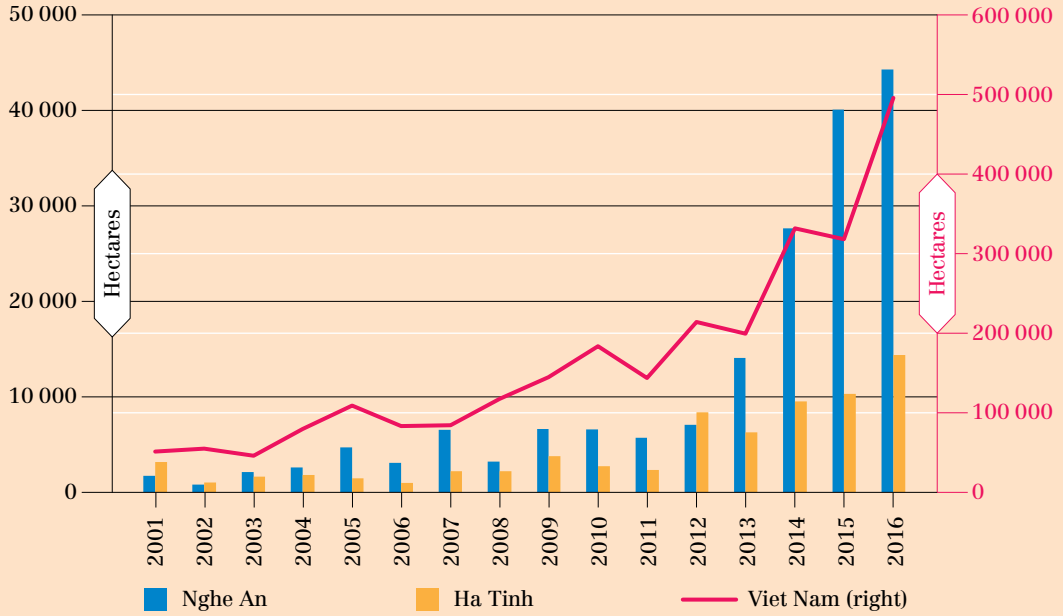
25 Used by MARD for Viet Nam's modified submission on Reference Levels for REDD+ Results–based Payments under United Nations Framework Convention on Climate Change (UNFCCC). These data were not available for the selected provinces.

26 Based on Circular No. 34 of 2009, the MARD developed in 2010 a 17 land uses classification system, which includes 12 forest types: evergreen broadleaf (rich, medium, poor) forest; evergreen broadleaf – regrowth; plantation forest; deciduous forest; bamboo forest; mixed woody–bamboo forest; coniferous forest; mixed broadleaf–coniferous forest; mangroves forest; and limestone forests.

27 These figures are unable to mitigate the impact of plantation harvesting cycles. The authors acknowledge that ignoring this might result in an overestimation of forests replaced if tree cover loss was associated with plantation harvest dynamics rather than plantations or other agricultural commodities replacing natural forests. And this risk is particularly high in the selected provinces where historically planned conversion of mainly poor natural forests to rubber, and other plantation crops has been a significant driver of deforestation (MARD, 2018a).

The annual tree cover loss has increased nearly ten times in less than two decades in both Nghe An and Ha Tinh, similarly to the national level trends (see Figure 19). Planted or recovered forests that are of lower quality have been gradually substituting natural forests, including the primary ones.

FIGURE 19 Tree cover loss, 2001–2016



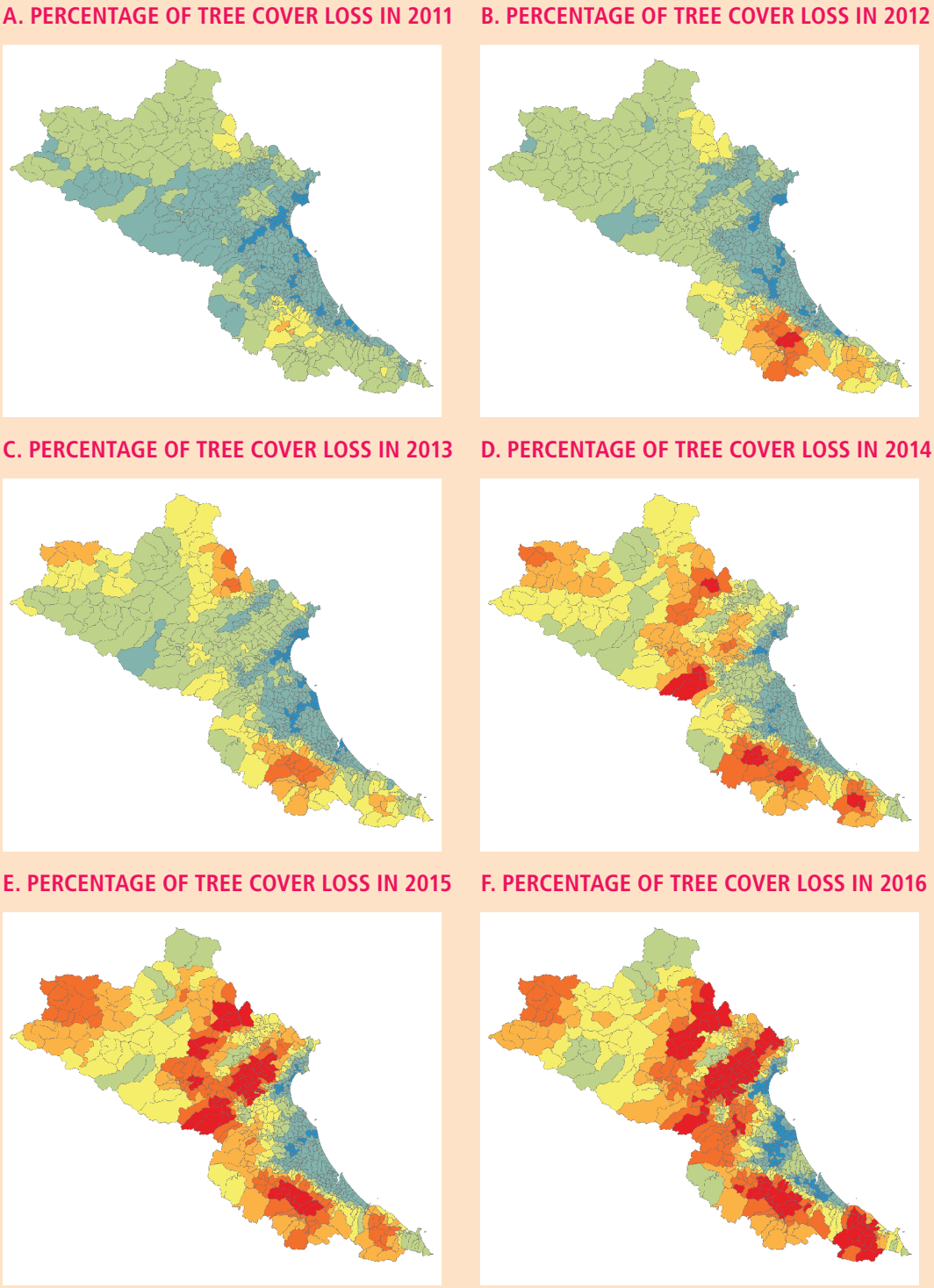
Source: Authors' elaboration based on Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O. & Townshend, J.R.G. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, 342(6160): 850–853. https://doi.org/10.1126/science.1244693

The spatial distribution of the yearly percentage loss of tree cover area from 2011 to 2016 illustrates the dynamic changes in forest loss in the two provinces, showing that tree loss has aggravated and spread through many communes (see Figure 20). High levels of tree cover loss (>5 percent) appeared in the communes located in the southwest of Ha Tinh in 2012, and also in the northeast of Nghe An in 2013. From 2014 onwards, tree loss accelerated (>8 percent) in the rural areas surrounding the urban coastal areas, which continue to intensify and expand throughout 2015 and 2016. Overall, the number of communes that experience up to 25.1 percent of tree loss increases substantially year by year during the period.

The areas with higher levels of initial tree coverage observed higher cumulative tree loss measured in ha (see Figure 21a). Most of the communes in the west experienced more than 424 ha of tree loss, but many others experienced more than 720 ha of tree loss, and some even more than 1 500 ha of tree loss in the span of six years. However, in relative terms (see Figure 21b), the cumulative percentage of tree loss was highest (>19 percent) in the central areas of Nghe An and the central areas of Ha Tinh. Some communes experienced more than 43 percent of tree loss in the span of six years. The distribution of the cumulative tree losses across the two provinces is spatially autocorrelated:[28] deforestation is increasing in the areas that have already experienced tree cover loss in previous years.

[28] Measured with Moran's I autocorrelation test (I=0.24, p–value=0.00).

FIGURE 20 Yearly percentage of tree cover loss per commune in Nghe An and Ha Tinh, 2011–2016



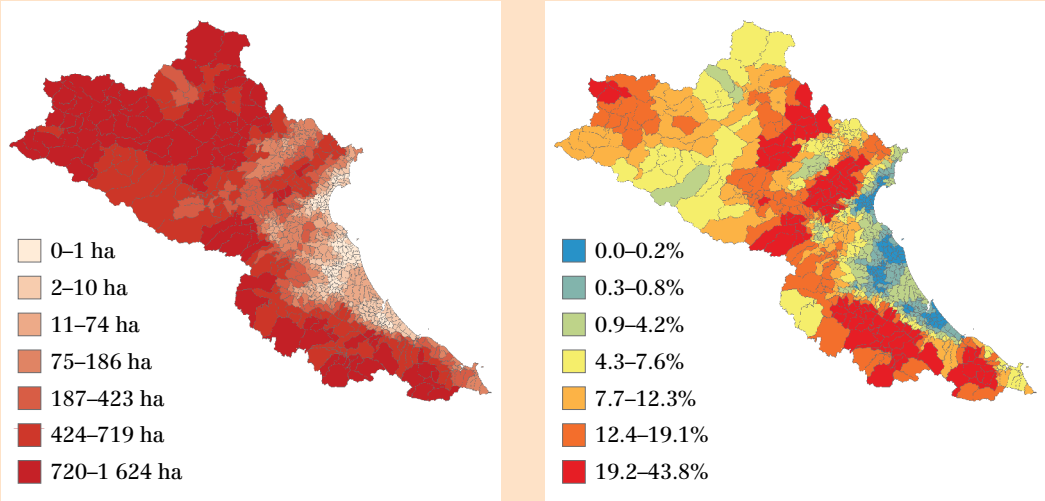
Percentage of forest loss

0% | 0.1–0.3% | 0.4–1.4% | 1.5–2.8% | 2.9–4.9% | 5.0%–7.9% | 8.0–25.1%

Source: Authors' elaboration based on Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O. & Townshend, J.R.G. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, 342(6160): 850–853. https://doi.org/10.1126/science.1244693

FIGURE 21 Tree cover loss per commune in Nghe An and Ha Tinh, 2011–2016

A. CUMULATIVE TREE COVER LOSS **B. PERCENTAGE OF TREE COVER LOSS**



Source: Authors' elaboration based on Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O. & Townshend, J.R.G. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, 342(6160): 850–853. https://doi.org/10.1126/science.1244693

BOX 6 Insights from the field

Several key stakeholders* interviewed during FAO's field visit pointed out that forest loss related to the conversion of forest land for commercial purposes to gain economic returns is backed by several factors. The lack of means to profit from the forests under management certainly pushes the conversion of forest land for productive uses, and the absence of compensation mechanisms for households responsible for preserving natural forests impedes the existing protection efforts. Unclear borders of the forest land managed by different entities, coupled with poor land planning and lack of compliance with forestry laws, result in forest land at times overlapping with land under other uses, often for agricultural activities. The lack of budget for forest protection enforcement and the subsequent shortage in forest protection officers has also been highlighted as another challenge in carrying out regulatory activities.

Annex 7 provides more details on the information gathered during the field interviews.

* Such as Nghe An Department of Crop Cultivation and Plant Protection, national and local Forest Protection Departments, Tan Ky Forest Protection Unit, Viet Nam Forest Protection Research Center.

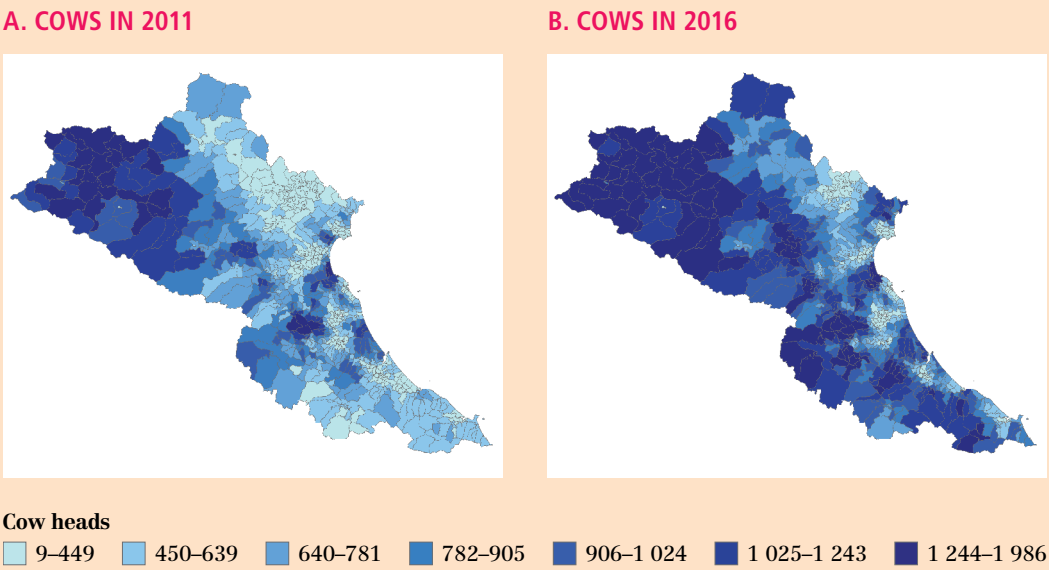
Source: FAO field visit in 2020.

5.2 Cow rearing as a crucial livelihood component in Nghe An and Ha Tinh

Cow rearing plays a very important role in Nghe An and Ha Tinh provinces, supporting rural livelihoods and agricultural sector growth. According to the agricultural census (RAFC, 2016, about one-third of the provinces' rural population holds at least one cow, with the absolute number also increasing in recent years (from about 270 000 to 300 000 households between 2011 and 2016).

The cattle population in Nghe An and Ha Tinh has significantly increased in recent years, reaching, in 2018, 450 000 heads in Nghe An and 192 000 heads in Ha Tinh (GSO, 2020). Figure 22 displays the number of cow heads in 2011 and 2016 per commune. It suggests that the overall increase in the number of cows have been accompanied by the change in spatial distribution of animals kept. The number of cows in 2011 was highest in the northwestern area of Nghe An, with lower levels across the rest of the provinces. However, cow heads in 2016 have expanded near the predominant northwestern area of Nghe An, and populated new areas in the western inland areas of Nghe An and Ha Tinh. In 2016, therefore, the distribution of cow rearing across the provinces appeared more spatially uniform from the north to the south of the provinces, with lower level of rearing only within the cities, but with a few clusters of highly intensive production in the cities' outskirts. This seems to confirm that the cow sector is going in the direction given by government policies[29] (see Chapter 3), which aim at relocating livestock production out of the urban centres, among other objectives. It is likely that the increase and expansion of cow heads across the peripheries of the provinces are putting higher pressure on the provinces' forests.

FIGURE 22 Cow heads per commune in Nghe An and Ha Tinh, 2011 and 2016

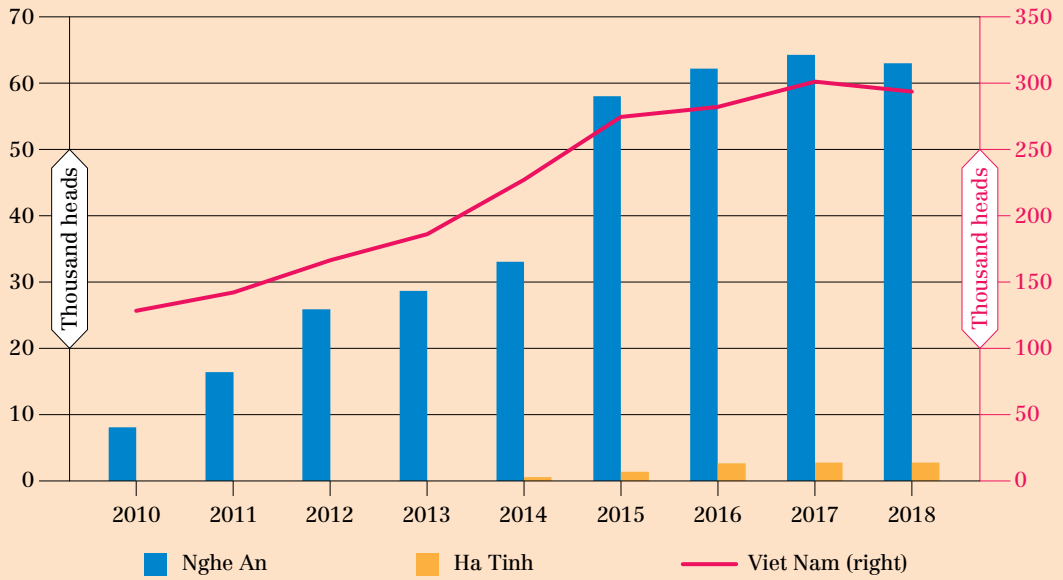


Sources: Authors' elaboration based on GSO. 2011. *Rural, Agriculture and Fishery Census.* Hanoi, and GSO. 2016. *Rural, Agriculture and Fishery Census.* Hanoi.

The majority of cattle in the provinces (90 percent) is reared for beef (GSO, 2020). The remaining 10 percent is for dairy, still, Nghe An is currently the second province with the largest share of dairy herd in Viet Nam (21 percent of all dairy cows in Viet Nam). In the period 2010–2018, the number of dairy cows in Nghe An expanded by seven times, growing from eight to 63 000 heads (IPSARD, 2020; see Figure 23). This huge increase was mostly driven by the establishment of two large dairy farms, TH TrueMilk and Vinamilk, in 2009. In Ha Tinh dairy cows were introduced only from 2014 onwards (see Figure 23), following the establishment of a dairy farm of Vinamilk.

[29] Decision No. 899 of 2013 on Agricultural Sector Restructuring Project.

FIGURE 23 Dairy cattle population, 2010–2018



Source: IPSARD. 2020. *Value chain review of beef and citrus sector.* Hanoi.

5.3 The relationship between beef and dairy sectors and deforestation in Nghe An and Ha Tinh: an empirical perspective

This section presents the results of an empirical analysis aiming at establishing the evidence of the linkages between beef and dairy production and deforestation in Nghe An and Ha Tinh provinces. The empirical analysis tries to answer two main research questions:

1. Do higher levels of cow rearing correspond to higher levels of deforestation?
2. Can cow rearing also impact the level of deforestation beyond the commune in which they are found?

The analysis develops on a wide set of information obtained from the spatial merge between two national agricultural censuses for the years 2011 and 2016 (RAFC, 2011; RAFC, 2016), including information on cow rearing, and a set of refined and updated geo-localized indicators of deforestation, infrastructural development and economic activity (more details on data used are provided in Annex 6).

The study uses the tree cover loss indicator derived from the GFW database (Hansen *et al.*, 2013) as a proxy for deforestation. These data include tree plantations and agricultural tree crops and may also include harvesting cycles of plantations, not providing a clear picture of net deforestation. However, plantation harvests made up only 8 percent of all tropical tree cover loss from 2013 to 2019 (Harris, Goldman and Gibbes, 2019) and in the absence of spatially explicit multi-temporal datasets for rubber and wood fibre plantation extent which are the predominant varieties in Viet Nam, the study is unable to mitigate the impact of plantation harvesting cycles. Ignoring this, however, might result in an overestimation of forests replaced, if tree cover loss in these provinces was actually a result of plantation harvests rather than forest clearing for other purposes. This risk is particularly high in the selected provinces which have a significant share of planted forests. Yet, given the low share of plantation harvests, the overestimation is likely to be marginal. Further, the lack of more suitable data makes it difficult to alleviate this issue. As a result, this analysis follows the

approach of using tree cover loss data as the best available estimates that serve as proxy for deforestation, an approach commonly used in other studies as well (including Goldman *et al.*, 2020; Pendrill *et al.*, 2019a, 2019b; Galiatsatos *et al.*, 2020).

Using the tree cover loss data and commune level cow rearing data from the census, the study employs a methodological approach to address the two main research questions to the extent feasible and is divided into two steps (Annex 6 provides full details on the methodological approach and results). In the first stage the focus is on studying the cross-sectional (for the year 2016) and dynamic (for the period 2011–2016) correlation between deforestation and cow rearing, using a simple log-log ordinary least squares (OLS) specification. The second stage focuses on studying the spatial correlation between deforestation and cow rearing, using a Spatial Durbin Model (SDM). The empirical study, however, encounters two problems. First, many factors influence deforestation, and many other commodities together drive the rate of deforestation. Therefore, from an empirical perspective, it is hard to separate out the marginal effect of beef and dairy sectors on deforestation and establish direct causality. Second, significant challenges associated with the lack of comprehensive geo-spatial data limited the scope of the analysis. The subsequent discussion of the main results keeps these important caveats in sight.

The results demonstrate that cow rearing was positively and significantly correlated with tree cover loss in 2016 (see Table 2). At a national level, an increase of 1 percent in cow heads per capita is correlated to an increase in tree loss by 0.13 percent. For the selected provinces, the correlation is much stronger: an increase of 1 percent in cow heads per capita is correlated to an increase in tree loss by 3.4 percent.

High levels of recent deforestation are observed in areas with high levels of forest land, remote areas distant from the cities and roads (where deforestation most likely has already occurred in more previous years), and with less human activity. This result underscores that deforestation is a phenomenon occurring outside the outskirts of cities and strongly driven by agricultural expansion. Further support to this statement derives from the results associated with the share of the population that is self-employed, who often engage in agricultural and resource extractive activities: an increase of 1 percent in self-employed individuals increases the deforestation by between 6 and 8 percent.

Cow rearing is also correlated with higher cumulative areas of tree loss during the period 2011–2016, for both the national sample and the sample composed by communes belonging to the selected provinces. In terms of magnitude, for the two provinces, an increase in the number of cows per capita by 1 percent between 2011 and 2016 is associated with an increase of 0.21 percent in tree loss. This translates into an additional loss of 3.93 ha of forest area, on average, per each 1 percentage increase in number of cows per capita.

To explore the relationship between herd-size of cows and deforestation, cow rearing households were further divided into those raising only 1 cow, those with a herd-size between 2 and 10 cows, and those with a herd-size of 11 or more cows. The results indicate that in the selected provinces, the correlation between cow activities and tree cover loss in 2016 was driven by the households specialized in cow rearing i.e. those with a herd-size of more than 11 cows (see Table 3). These results are consistent when adjusted to see the effect of a percentage increase in households raising only one cow, two to ten cows, and 11 or more cows on cumulative areas of tree loss during the period of 2011 to 2016 (see Table 4).

Cow rearing activities can also impact the level of deforestation beyond the commune in which they are conducted. Estimates in Table 5 provide evidence of a spatial correlation of this activity in nearby communes, suggesting that its uncontrolled expansion could increase the level of deforestation in the surrounding areas as well. The estimated coefficients remain consistent even when fitting them in the same SDM while adding further commune-level controls.

The literature offers a number of possible explanations for the above effects to occur. The first explanation relies on the so-called demand effect, where the increase in the local demand for cows will influence new farmers to enter into the production to capture this new potential rent. Second, there may be a supply effect, where farmers with higher returns from the activity decide to re-allocate some of it from the frontiers of the agricultural production into the forest lands (see, among others, de Sá, Palmer and Di Falco [2013]; Meyfroidt *et al.* [2014]). Third, recent literature suggests that areas with higher land conversion to agriculture can induce more deforestation in nearby zones (Richards, Walker and Arima, 2014). Higher agricultural activities in the spatially contiguous zones can lead to higher capital available to farmers and to the so-called land appreciation effect, involving farmers that invest the new capital in the nearby agricultural communes to capture the expected rent from the conversion of forest land into cropland. Finally, it is possible that the spatial correlation derives from a supply effect, but in the overall value chain. Especially for the value chain of beef, it is possible that more actors are attracted by the increased returns from cow production and tend to invest in the upstream segment of the value chain, for example in farms for breeding and fattening.

Overall, the results from the analysis suggest a significant positive correlation between cow rearing and tree cover loss. However, it is important to note that the results alone do not establish the causality (e.g. it is unable to conclude that the tree cover loss was caused by increased cow rearing activities alone). To better understand the mechanisms underlying the observed correlation and provide insights on potential sources of possible causal relationship, the following section analyses the beef and dairy value chains in the two provinces.

TABLE 2 Beef production activities are associated with an increase in tree loss measured by satellites, 2016

	All Viet Nam	Selected provinces
Variables	Tree loss area in 2016 (ln)	Tree loss area in 2016 (ln)
Cows per capita (ln)	0.130***	0.218 ***
	(0.008)	(0.076)
Socioeconomic controls	Yes	Yes
Infrastructural and satellite controls	Yes	Yes
Ethnic controls	Yes	Yes
Observations	9,904	724
R-squared	0.478	0.584

Notes: The table reports the estimated coefficient from an OLS model with the natural log of the tree losses in 2016 as the dependent variable. The unit of observation is the commune, and the main explanatory variable is the natural log of the cow units. Level of significance are *** p<0.01, ** p<0.05, * p<0.10. Errors are clustered at the commune level. For the full list of coefficients of the provincial sample refer to Table A6 in Annex 6.

Source: Authors' own elaboration.

TABLE 3 Increase in tree loss from beef production activities are driven by households specialising in cow rearing

	Selected provinces
Variables	Tree loss area in 2016 (ln)
Number of households raising 1 cow	-0.000
	(0.000)
Number of households raising 2–10 cows	0.001
	(0.000)
Number of households raising 11 or more cows	0.053***
	(0.014)
Socioeconomic controls	Yes
Infrastructural and satellite controls	Yes
Ethnic controls	Yes
Observations	726
R-squared	0.722

Notes: The table reports the estimated coefficient from an OLS model with the natural log of the tree losses in 2016 as the dependent variable. The unit of observation is the commune and the main explanatory variables are the natural log of the number of households raising 1 cow, number of households raising 2–10 cows, and the number of households raising 11 or more cows. Level of significance are *** p<0.01, ** p<0.05, * p<0.10. Errors are clustered at the commune level. For the full list of coefficients of the provincial sample refer to Table A6 in Annex 6.

Source: Authors' own elaboration.

TABLE 4 A percentage increase in households specializing in beef production is associated with increase in cumulative tree loss, 2011–2016

	Selected provinces
Variables	Log of cumulative tree loss (11–16)
Log difference in number of households raising 1 cow (2016–2011)	0.189
	(0.115)
Log difference in number of households raising 2–10 cows (2016–2011)	-0.106
	(0.118)
Log difference in number of households raising 11 or more cows (2016–2011)	0.252***
	(0.071)
Socioeconomic controls	Yes
Infrastructural and satellite controls	Yes
Ethnic controls	Yes
Observations	726
R-squared	0.765

Notes: The table reports the estimated coefficient from an OLS model with the natural log of the cumulative tree losses in the period 2011–2016 as the dependent variable. The unit of observation is the commune and the main explanatory variables are the log-difference of the number of households raising one cow, number of households raising 2–10 cows, and the number of households raising 11 or more cows for the period 2011–2016. Level of significance are *** p<0.01, ** p<0.05, * p<0.10. Errors are clustered at the commune level. For the full list of coefficients of the provincial sample refer to Table A7 in Annex 6.

Source: Authors' own elaboration.

TABLE 5 Spatial effect of increase in cow activities on cumulative tree loss in Nghe An and Ha Tinh, 2011–2016

	Nghe An	Ha Tinh
Variables	Log of cumulative tree loss (11–16)	Log of cumulative tree loss (11–16)
Log difference in total number of cows per capita (2016–2011)	0.120***	0.089***
	(0.025)	(0.023)
Neighbours effect of total number of cows per capita	0.000***	0.001**
	(0.000)	(0.000)
Other controls	No	Yes
Observations	683	683
Global Moran I (P-value>0)	0.95 (0.00)	0.06 (0.00)
LR Test SDM vs OLS (P-value>Chi2)	89.62 (0.00)	14.36 (0.00)

Notes: The table reports the estimated coefficient from a Spatial Durbin Model, with the natural log of the cumulative tree losses in the period 2011–2016 as the dependent variable. The model includes a binary contiguity matrix for computing the spatial spill over effect. Level of significance are *** p<0.01, ** p<0.05, * p<0.10 and errors are spatially clustered. Full list of coefficients is available upon request.

Source: Authors' own elaboration.

5.4 Leveraging value chain analysis to identify the linkages between cow rearing for beef and dairy and deforestation

The analysis of dairy and beef value chains (VC) in Nghe An and Ha Tinh provinces aims to understand how cow rearing, and subsequent production of beef and milk, could be contributing to deforestation and how this relationship may evolve in the future. By exploring each stage of the value chain, the analysis investigates the potential channels of impacts on deforestation and identifies possible entry points for policy reforms and investments to reduce pressure on forests.

Dairy value chain analysis

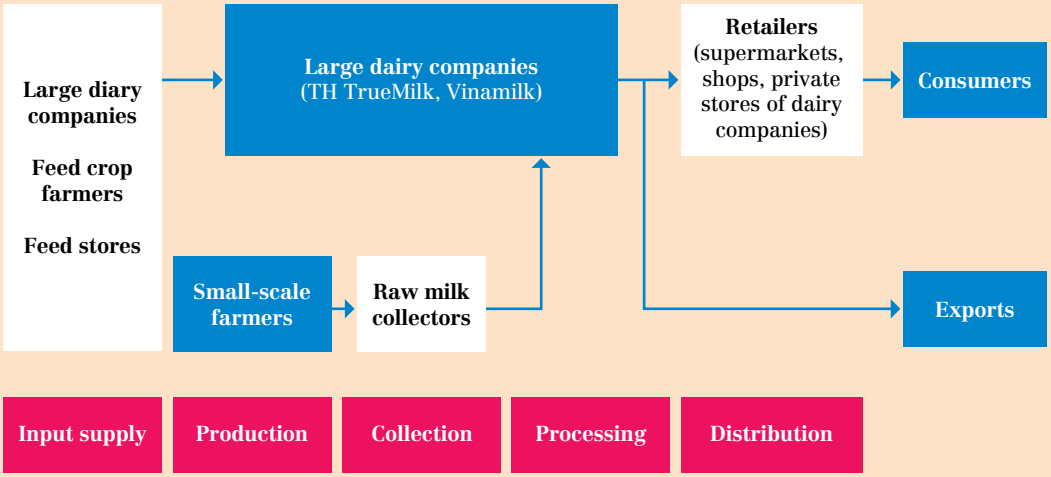
The dairy value chain is rather simple and mainly consists of large dairy companies operating in the provinces, TH TrueMilk and Vinamilk (see Figure 24), established first in 2009.[30] The companies' cow herds make up almost all the provincial dairy cattle population[31] and they produce almost all raw milk in the provinces. Small and medium-scale dairy farmers produce only a small share of raw milk under the contract with Vinamilk. All processing is conducted by the two dairy companies, who then also distribute dairy products to retailers (mainly supermarkets, mini-markets, shops and own stores), or export, to reach final

[30] TH TrueMilk was founded in 2009 in Nghia Dan district, in the northeastern part of Nghe An province, where it established three dairy farms, one dairy processing plant and a feed production company. Vinamilk established in 2009 a dairy farm in Thai Hoa town, and a dairy processing plant in Cua Lo town, respectively in the north–eastern and south–eastern part of Nghe An, and in 2014 a dairy farm in Huong Son district in the northern part of Ha Tinh.

[31] TH TrueMilk holds 45 000 cows and plans to have 70 000 cows by 2025. Vinamilk holds a much lower number of cows (about 2 600 in Nghe An and 2 000 in Ha Tinh), excluding the outsourced production to small dairy farmers.

consumers. At the input supply level, other actors participating in the dairy VC include feed crop farmers, doing contract farming with large dairy companies to sell feed crops, especially maize; feed processing companies; and stores.

FIGURE 24 Map of dairy value chain in Nghe An and Ha Tinh



Source: Authors' own elaboration.

Large dairy companies: vertical integration from input supply to processing and distribution

The large dairy companies participate in many stages of the value chain, from growing feed crops to distributing processed dairy products to end markets (see Tables 6 and 7). Their cow herd is made up of Holstein-Friesian (HF) cows imported mainly from the United States of America, Australia or New Zealand, with a lactation capacity of 30–35 litres per cow per day, reaching almost 11 000–13 000 litres per cow per year. This represents a high-quality breed, for high quality end products.

Their production system is intensive and highly technologically advanced. Cows are reared in stalls, where they are milked and fed. Herd management tools consist of a recording system in which each cow has an electronic chip registering milk quantity and quality, monitoring cow health and cow movements. An automatized feeding system timely distributes a combination of different feeds to cows, tailored to the cow's age for a more accurate nutrition. Animals' health is closely monitored through the electronic chip, and manure efficiently managed to reduce its polluting impact.

The main feed components for dairy cows are fresh fodder and grains, and concentrated feed. Fresh fodder and grains mainly include grass and maize, and to a lesser extent also Mulato, sunflower and sorghum. These are in part produced in-house by the companies (about 60 percent) on land devoted to feed crop cultivation[32] and in part purchased from farmers within the province (about 40 percent).

[32] With a total land area of 8 100 ha, TH dedicates 4 000 ha to Mombasa grass, maize, Mulato, sorghum and sunflower cultivation, while from farmers it purchases mainly maize. Some alpha–alpha grass is also imported from the United States, which consists about 2 percent of all feed. Concentrated feeds are supplied by a feed production company, a member of TH TrueMilk, which produces them according to company–defined formulas. Vinamilk outsources fresh fodder cultivation (grass and maize) contracting with farmers in nearby districts, then the maize silage is produced internally. Commercial feed (bran) is instead provided by CJ feed company (Korean) which contracts with Vinamilk to produce the required combination of feeds according to Vinamilk's formulas. Some alpha–alpha grass is imported from the United States of America.

The milking system is also automatic, and each cow is milked two or three times a day. Fresh raw milk directly passes through a cooling pipe and is stored in a cool tank, and then transferred to the dairy processing plant two to three times a day through specialized vehicles.

Raw milk is then processed and transformed into dairy products. All raw milk processing is conducted in-house in modern facilities. Dairy companies produce a very wide range of products, from fresh milk (ultra-high-temperature processing [UHT] or pasteurized), powder milk, yogurt in pots and drinking yogurts, to milk-cereal mixes, milk drinks, and condensed products. Dairy products are eventually sold to retailers to reach the final consumers. These include supermarkets, mini-markets and private stores. A small share of dairy products is also exported.[33]

Outsourced production: small and medium dairy farmers

Dairy companies outsource part of the production by engaging in a contract with small and medium dairy farmers[34] located in nearby areas. The contract envisages that the company sells the young cows (HF breed), technology (milking machine), veterinary services and concentrated feed to the farmers, and then buys back raw milk at predetermined rates, depending on milk quality. Even though this represents a low share of total production, contract farming provides small/medium farmers with a great business opportunity and favourable market connections.

Raw milk produced by small/medium dairy farmers is collected and shipped to the dairy processing plant. The collection process involves farmers who deliver the raw milk to the company's milk collecting points at each commune in the dairy production area and the dairy company, which picks up milk twice a day through collectors (JICA, 2019). These can be either independent collectors who contract with the dairy company, or collectors belonging to the dairy company itself. Transportation occurs through specialized vehicles. Once raw milk reaches the dairy processing plant, it is mixed with milk produced by the company and then follows the same process (see the previous section). The dairy company is very strict with respect to raw milk quality requirements. The price of raw milk is strictly linked to its quality, and if quality requirements are not met, the company will not purchase it. Yet, this process still presents a few challenges. As farmers lack the knowledge of proper dairy cow rearing techniques and procedures, it may hinder the productivity, and consequently the profitability, of the farm.

Upstream linkages: contracting with small and medium feed crop farmers

Feed supply is a cornerstone in the dairy value chain in the provinces, as a very large cow herd comes with huge feed requirements. The procurement of a large share of feed crops (especially grass and maize) from farmers within the provinces gives room for establishing crucial links with provincial feed crop cultivation. Due to the huge feed requirements, and the obstacles in acquiring new land to cultivate crops, contracting with farmers is key for the company to ensure feed supply.[35]

[33] The main destination countries include the United States of America, Near East, South America, Africa, the European Union, Southeast Asia and China.

[34] Vinamilk engages in contracts with 70 small/medium dairy farmers within the provinces to buy raw milk produced by them, with the purchase quantity of approximately 5.5 tonnes/day. They are mainly located in Nghia Dan, Quynh Luu districts and Thai Hoa town, somewhere close to the large dairy companies. Since 2011, Vinamilk has provided 472 dairy cows to small farmers through contracts (FAO Field visit, 2020).

[35] TH TrueMilk currently purchases 100 000–120 000 tonnes of maize annually from farmers, involving about 20 000 people and 5 000 ha of land. Vinamilk farm in Nghe An purchased 10 500 tonnes of grass and 12 700 tonnes of maize in 2019 from small farmers in the province (around 90 percent of its maize demand). Vinamilk farm in Ha Tinh estimates that half of the fresh fodder is produced internally, and half is purchased (of which 2 500 tonnes of grass and 12 000 tonnes of maize were purchased).

Contracts also represent a beneficial opportunity for feed crop farmers in terms of market opportunity and economic returns. In some cases, agricultural cooperatives may intermediate between farmers and the company, helping farmers to improve the quality of maize and facilitating sales. More and more farmers will likely engage in feed crop cultivation, pulled by the potential economic opportunities, possibly inducing land use changes including (illegal) conversion of non-agricultural land for feed crop production.[36]

Considering the projected expansion of the sector in the near future[37] and the issues concerning further land acquisition (lack of available land and land use constraints discussed in detail in Chapter 2), purchasing feed crops from farmers will likely be increasingly more important in the near future, especially that the share of imported feed is very small.

Key challenges

Even though no critical bottlenecks are identified, the dairy value chain in Nghe An and Ha Tinh shows some features that could easily be reverted into challenges. The very large cow herd entails huge feed requirements (especially maize) which have been evolving into fierce competition to ensure feed crop supply at the province level, and even beyond. Considering TH TrueMilk's intentions to expand and the issues concerning further land acquisition (lack of available land and land use constraints discussed in detail in Section 2), purchasing feed crops from farmers will likely be increasingly more important in the near future, especially that the share of imported feed is very small. In addition, more and more farmers will likely engage in feed crop cultivation, especially maize, pulled by the potential economic opportunities. This may possibly induce land use changes including (illegal) conversion of non-agricultural land for feed crop production. Further, dairy companies, to properly carry out their operations, require a great infrastructural support that may involve important infrastructural investments such as construction of new buildings and roads. It is also a highly resource-intensive production system (e.g. water). Overall, it is clear that land requirements are crucial for the dairy sector development, which with existing land scarcity and land use constraints increase significantly risks of deforestation.

TABLE 6 TH Truemilk company details

Nghe An
Establishment year: February 2009
Location: Three mega-farms and dairy plant in Nghĩa Sơn commune, Nghĩa Đàn district, Nghệ An province
Land area: 8 100 ha; 4 000 ha for feed crops: Mombasa grass, maize, Mulato, sorghum and sunflower
Number of cows: 45 000
Milking capacity: 34 litres/cow/day
Intention to expand (within the province): Plan to have 70 000 cows by 2025

Sources: FAO field visit in 2020; JICA (Japan International Cooperation Agency). 2019. *Technical Cooperation Project on Development Planning of Agriculture Sector in Nghe An in the Socialist Republic of Viet Nam.* Tokyo.

36 Vinamilk outsources feed crop production (grass and maize) to farmers in nearby districts through two main types of contracts, which either imply i) lending farmers the company's own fields to cultivate the feed crops that Vinamilk will buy back (about 25 ha); or ii) directly purchasing the proportion of fresh fodder demand not satisfied through company's own fields.

37 TH TrueMilk has the goal of holding up to 70 000 cows by 2025.

TABLE 7 Vinamilk company details

Nghe An	Ha Tinh
Establishment year: 2009	**Establishment year:** October 2014
Location: Farm: Đông Hiếu commune, Thái Hoà town Dairy production plant: Cửa Lò town	**Location:** Farm: Sơn Lễ commune, Hương Sơn district
Land area: 47 ha ◆ Facilities: 20 ha ◆ Feed crops: 25 ha ◆ Air-conditioning lake: 2 ha	**Land area:** 42 ha ◆ Facilities: 18 ha ◆ Feed crops: 20 ha ◆ Others: 4 ha
Number of cows: 2 618 (max capacity: 3 000)	**Number of cows:** 2 000
Milking capacity: 29 litres/cow/day	**Milking capacity:** 30 litres/cow/day
	Intention to expand: Huong Khe district in Nghe An

Source: FAO field visit in 2020.

Beef value chain analysis

The beef sector in Nghe An and Ha Tinh is still very traditional (see Figure 25). Although important in size, the beef value chain is rather fragmented, and the VC stages remain basic. Some medium to large commercial farms have started to emerge in recent years, yet small family farms continue to represent the main production system. No specialization exists. Traders purchase live cattle from small farmers and distribute them for slaughtering and processing. Commercial farms generally sell directly to slaughterhouses. Processing is at a very early stage. Meat is distributed to wholesalers and retailers who usually sell in surrounding local markets. The large share of meat, particularly coming from small family farms, is sold without cooling. Two main market segments and two distinct value chains may be identified, as follows:

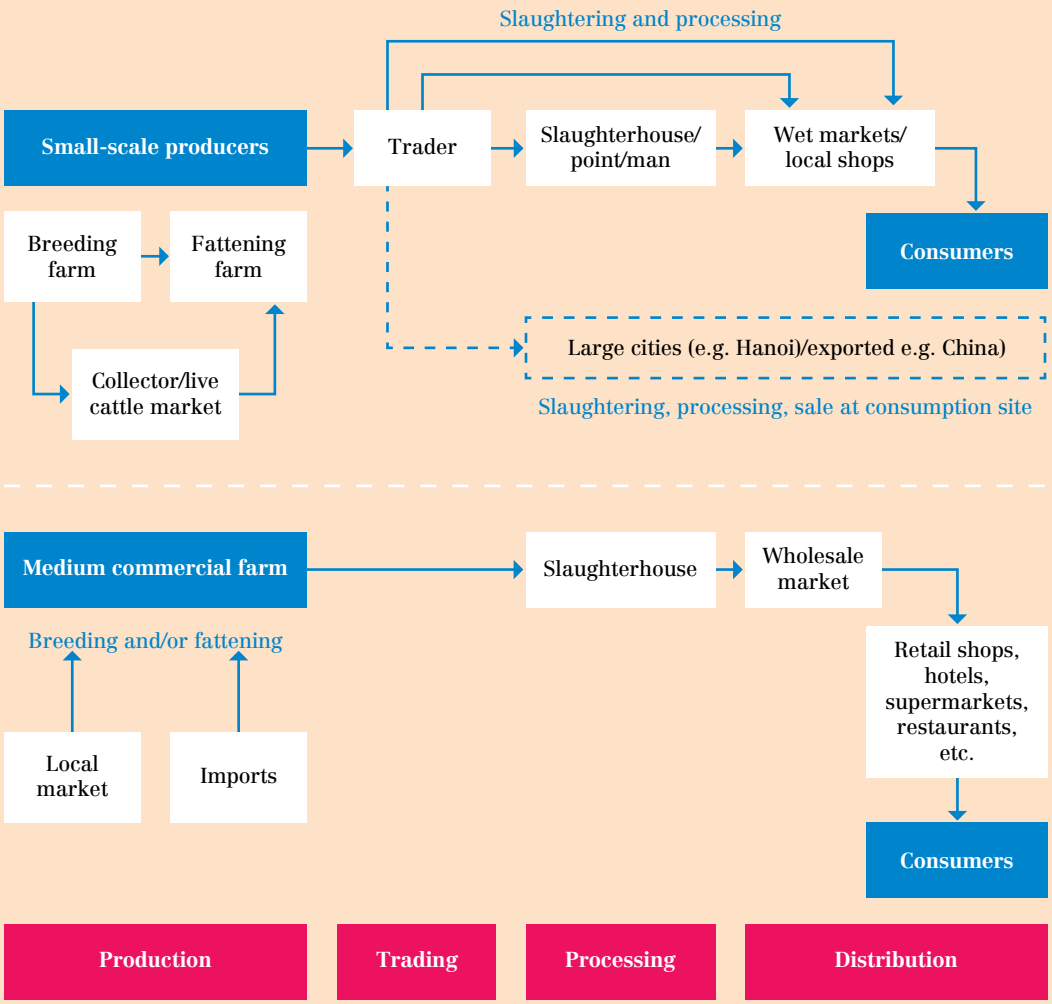
- Low-value chain: small family farms ► traders ► slaughterhouses ► wet markets/local shops ► final consumers
- Medium-value chain: medium-scale commercial farms ► slaughterhouses ► supermarkets/retailers/hotels/restaurants ► final consumers

Small family farms

Small-scale family farmers with two to ten cows per farm dominate beef production in Nghe An and Ha Tinh (GSO, 2016). They are principally involved in cow breeding, rarely in fattening activities. Farmers tend to purchase cows from their neighbours, which they rear until they give birth and then sell the young calves when they reach a certain age. They sell live cattle directly to traders or at provincial live cattle markets.[38] Generally, farmers do not set a specific age for sale, which is rather determined by when a trader passes by or by the actual need to sell.

[38] Such as U Market in Do Luong, or Con Market in Thanh Chuong (Nghe An).

FIGURE 25 Map of beef value chain in Nghe An and Ha Tinh



Source: Authors' own elaboration.

The main breed is local yellow cattle,[39] a breed that adapts well to limited low quality feed resources and still remains productive (Pham, Smith and Phan, 2015, Parsons *et al.*, 2013). Some farmers own Sindhi hybrid cattle (also called Lai Sind breed in Viet Nam), which have greater physiological needs, but also the ability to adapt well to the hot and humid climatic conditions (Pham, Smith and Phan, 2015).

Cattle rearing relies on grazing (Pham, Smith and Phan, 2015, Parsons *et al.*, 2013). The grazing areas are generally small as smallholder farmers do not own large parcels of land and available land is used to grow crops.[40] Usually, cattle either graze in the fields to eat crop residues when fields are not under cultivation, in common pastures or in the nearby forests (Cesaro, Duteurtre and Nguyen, 2019). Besides grazing, farmers provide cows with fodder mainly in the form of grass (natural or elephant), and roughages such as rice straws, maize leaves,[41] cassava leaves and sugar cane leaves, all coming from own crop cultivations.

39 Local yellow breed makes up the 70–90 percent of cattle herd in extensive cow–calf systems (Pham, Smith and Phan, 2015).

40 According to census data (GSO, 2016), farmers with 2–10 cows own on average 0.9 ha of land, which is split between crop cultivation and forest (respectively 0.4 and 0.5 ha on average).

41 In some cases, both maize grains and leaves are used as beef cattle feed.

Silage and other fodder storage techniques are barely adopted. Although less commonly, some farmers also provide concentrated feeds such as rice bran. Overall, smallholders self-manage feed for their livestock and rarely buy from stores, which constitutes a low-input and poor feeding practice.

The government provides cow vaccinations twice a year, and farmers in certain communes receive financial support. Veterinary drugs are supplied by local stores. However, some uncertified medicines also circulate (JICA, 2019), which may hinder productivity by putting animal health at risk.

Farmers' linkages to the downstream segments of the value chain are poor. Farmers are rarely part of farmers' associations (Dung *et al.*, 2019) which would have helped favour knowledge sharing, strengthening bargaining power, or bottleneck identification. They do not have properly established relations with commercial businesses in charge of processing and retail, they are isolated from the markets and rely mainly on neighbours or by-passing traders for market information.

The lack of specialization in production, the poor knowledge and the scarce resources imply an underdeveloped, inefficient and low-quality production system. Without efforts to improve the production system, the growing demand for beef combined with government promotion of the beef sector expansion and related factors, will likely induce the continued diffusion of this inefficient production system following the already observed trends.[42]

Medium-scale commercial farms

Medium-to-large commercial farming has started to arise in the two provinces in the last few years, complementing the smallholder production system (Box 11 provides a few examples). They are typically involved in both breeding and fattening activities, with the degree of specialization increasing with the number of cows. Larger-scale actors (50–200 cows), tend to import Belgian Blue Beef (BBB) cattle from Australia, representing a higher quality breed with respect to yellow or Sindhi crossbreeds that are traditionally reared in the area. Medium-scale farmers (20–40 cows) generally buy cows from farmers around the area.

Commercial farms are rather intensive systems. Cows are kept in stalls and rarely graze on pastures, due to the large number of cow heads, lack of sufficiently big grazing land and inefficiency that grazing would imply in terms of fattening and breeding. Instead, the commercial farms are increasingly relying on feed concentrates, which are purchased at feed stores. They also provide roughage e.g. rice straws, maize or cassava or cane foliage, and maize grains to the cows, in part purchased from feed stores and in part produced in-house as commercial farms usually have some land dedicated to cultivating feed crops. Veterinary drugs are sourced from feed stores as well.

Commercial farms generally do not engage in other stages of the value chain, but mainly sell live cattle to slaughterhouses. There are very few exceptions of companies that breed and fatten cows and then regularly slaughter at a dedicated slaughtering point nearby, and eventually sell beef to retailers and restaurants in Hanoi.

This production system is more efficient and productive than small farmers' one, however, it also faces several constraints. Commercial farmers, though more specialized than small family farms, still lack adequate knowledge about cow rearing techniques that are necessary for the imported high-quality breeds, lowering productivity and increasing the business risk. Farmers' associations are virtually inexistent, and the lack of connections downstream the VC (slaughterhouses and further down the VC) further restrain market opportunities.

[42] As shown in the empirical analysis between 2011 and 2016 the number of households holding two to ten cows substantially expanded (GSO, 2011, 2016).

Feed suppliers

There are many feed companies and stores in the two provinces, and high competition exists among feed suppliers (FAO's field visit, 2020). The feed companies are mainly located in the industrial zone of Nghe An (JICA, 2019). They distribute their products through a wide network of local stores in districts and communes, particularly present in districts with a higher number of cows, such as Thanh Chuong, Tan Ky, Dien Chau.

As the beef sector continues to expand, the demand for feed follows the trend. Feed suppliers also expand, matching the increased demand for feed, building mainly on locally grown crops and to a lesser extent through imported feed components.

Traders

Traders play a crucial role in the low-quality beef value chain. They purchase live cattle directly from small farmers or in livestock markets and trading spots,[43] and then sell to slaughterhouses. While livestock markets take place several times per month, there are not established intervals for live cattle collection at farm gate. In addition, formal contracts are uncommon both upstream and downstream, while informal verbal agreements are the norm. Traders are responsible for weighting[44] the animals and set prices for the live cattle accordingly.

Traders may also purchase live cattle imported from the Lao People's Democratic Republic. A large share of these imports is illegal and sold at local markets at a lower price, reducing benefits to legally operating producers. It also increases the risks of spreading animal diseases as the illegal imports are not subject to any control (Pham, Smith and Phan, 2015).

Slaughterhouses

Slaughterhouses purchase live cattle either from traders or from commercial farms, and rarely directly from small family farmers. After slaughtering, they distribute raw beef to wholesalers and retailers, mainly in the provinces.

The slaughterhouses vary according to the scale and the degree of formality of the businesses. On the one hand, there are many small-scale, non-mechanized slaughterhouses, mostly family owned. Some illegal slaughter points may exist as well. Both tend not to be equipped in cooling storage facilities. They typically process the meat originating from small family farms. The lack of adequate infrastructure, the adoption of poor practices and scarce hygienic conditions render the meat produced through this channel to be suitable only for the low-value market. On the other hand, a few larger-scale, commercial slaughterhouses with mechanized processes complement the picture. They usually process the meat coming from the commercial farms. They also tend to be applying more traditional and rather basic meat processing technologies, but cold chain is more frequently used, and the meat is destined to the higher value market segment.

The slaughtering phase contributes to value chain inefficiency, low productivity and poor profitability, and raises serious food and labour safety issues as well as environmental concerns. In the majority of cases, market relations with segments further down the stream are not established and are dictated by short-term orders as needed.

Wholesalers and retailers

In the wholesale and retail distribution of the low value chain segment, the cold chain is also hardly used and meat originating from small scale family farms is mostly sold fresh on

[43] There is a considerable infrastructure for live cattle distribution at the provincial level (JICA, 2019). In Nghe An province, 13 livestock markets and about 300 trading spots for live cattle exist (JICA, 2019). The most important livestock market is U Market in Do Luong district, Nghe An.

[44] Live weight.

the day of slaughter in local stores or wet markets. Consumer preferences contribute to not using cooling systems as non-chilled fresh meat is more popular locally. Meat originating from medium scale commercial farms, processed by larger scale slaughterhouses, is typically of higher value and distributed using cold chain, mainly outside of the provinces, to supermarkets, hotels and restaurants.

Key challenges

Notwithstanding the size of the sector in the provinces, and its relevance in households' livelihoods, the beef VC is locked in a low productivity, low profitability and low efficiency cycle. The fragmentation of the current beef VC and the lack of connection between VC stages make it difficult for beef cow farms to expand, despite favourable market conditions, following the increasing demand for beef and government efforts to promote sector development. Both smallholders and commercial farms generally do not have proper access to the wider range of wholesale markets nor properly established connection to meat processing companies. Farms also lack proper knowledge of cow rearing techniques, which contribute significantly to hindering productivity and the profitability of the business. At the same time, the lack of modernized slaughterhouses and beef processing companies, which would use cooling systems, challenges the future expansion of the beef production in several ways. Aside from issues related to quality and food safety, it induces inefficiencies that may lead to important waste of meat. As demand will continue to grow, in order to meet consumer needs the supply side may need to respond more than it would normally do, if these inefficiencies were addressed. This, in turn, may lead to disproportionally greater use of resources to produce a given quantity of meat, increasing demand for a wide range of inputs, of which many will require additional land.

5.5 Unpacking the linkages between cow rearing for beef and dairy and deforestation

The analysis of dairy and beef value chains shows that the observed correlation between cow breeding and deforestation is mainly driven by increased demand for land, both directly and indirectly. The demand pressure for additional land has been already in place and is expected to increase. The increase will be driven by increasing consumer demand for beef and dairy products and government support to expand domestic production, both through the explicit promotion of the sectors' expansion and price distortions observed in markets for beef and feed. The increased pressure for additional land will unavoidably increase the risks of deforestation.

Linkages through direct pressures on demand for land

Establishing new farms, particularly new large dairy farms (see Box 7), or expanding existing ones, for both beef and dairy, requires additional land. Given the high efficiency of existing dairy farms, it is highly unlikely that any major increases of production can be achieved through further intensification of production as they are already highly developed and employ technologically advanced production systems. Beef production, on the other hand, is extremely inefficient and potential for improving productivity and increasing production within the existing capacity exists. Yet, if no action is taken to restructure and modernize the beef value chain, the future production expansion will require increased land devoted to cow rearing. Further, emerging medium and large-scale commercial farms, both in dairy and beef sectors, require larger land area to build necessary support on-farm and off-farm infrastructure, including concentrated barn structures (separately for breeding and fattening), slaughterhouses and meat processing plants, roads, etc. (see Annex 7). As no free agricultural land exists, the additional land will need to come either from conversion from

other uses within the sector, or more likely, outside the agricultural sector. Given the scarcity of available land, high competing demands for land from various sectors of the economy and existing land use constraints within the agricultural sector,[45] the additional land would likely come through further deforestation.

There has also been some evidence (Pham, Smith and Phan, 2015) that some smallholder households rear cows inside the forests, particularly those who reside in the neighbouring forest areas. Forest grazing provides a good opportunity for smallholders who have little land and limited feeding opportunities (see Annex 7 for evidence from FAO field trip in 2020). Although forest grazing does not lead to deforestation as such, it has important consequences for the quality of the vegetation as cows will degrade the lower forest layers to which they will have access. If unmanaged, this may lead to severe degradation of forests, reduction of forest density and increased risk of dieback of trees.

These conclusions confirm the findings from the empirical analysis showing that cow rearing is correlated with tree cover loss and suggest that this correlation is likely to become stronger if no action is taken.

Linkages through indirect pressures on demand for land

The expansion of beef and dairy sectors requires additional means to feed the growing number of animals. Increasing numbers of beef and dairy cows will need additional grazing land, more forage, more grains and more feed concentrates. As the beef and dairy value chain analyses show, the feed in both sectors comes in great majority from locally produced crops and the land area devoted to feed crops has been already expanding. This trend is very likely to continue in the future increasing further the demand for additional agricultural land. Combined with existing land pressures, this will additionally induce incentives for land acquisition through forest clearing.

This has been empirically demonstrated by the spatial correlation: more deforestation has been taking place in the nearby communes with more cow rearing activities (Section 5.3). Again, the evidence shows this is likely to intensify if no action is taken.

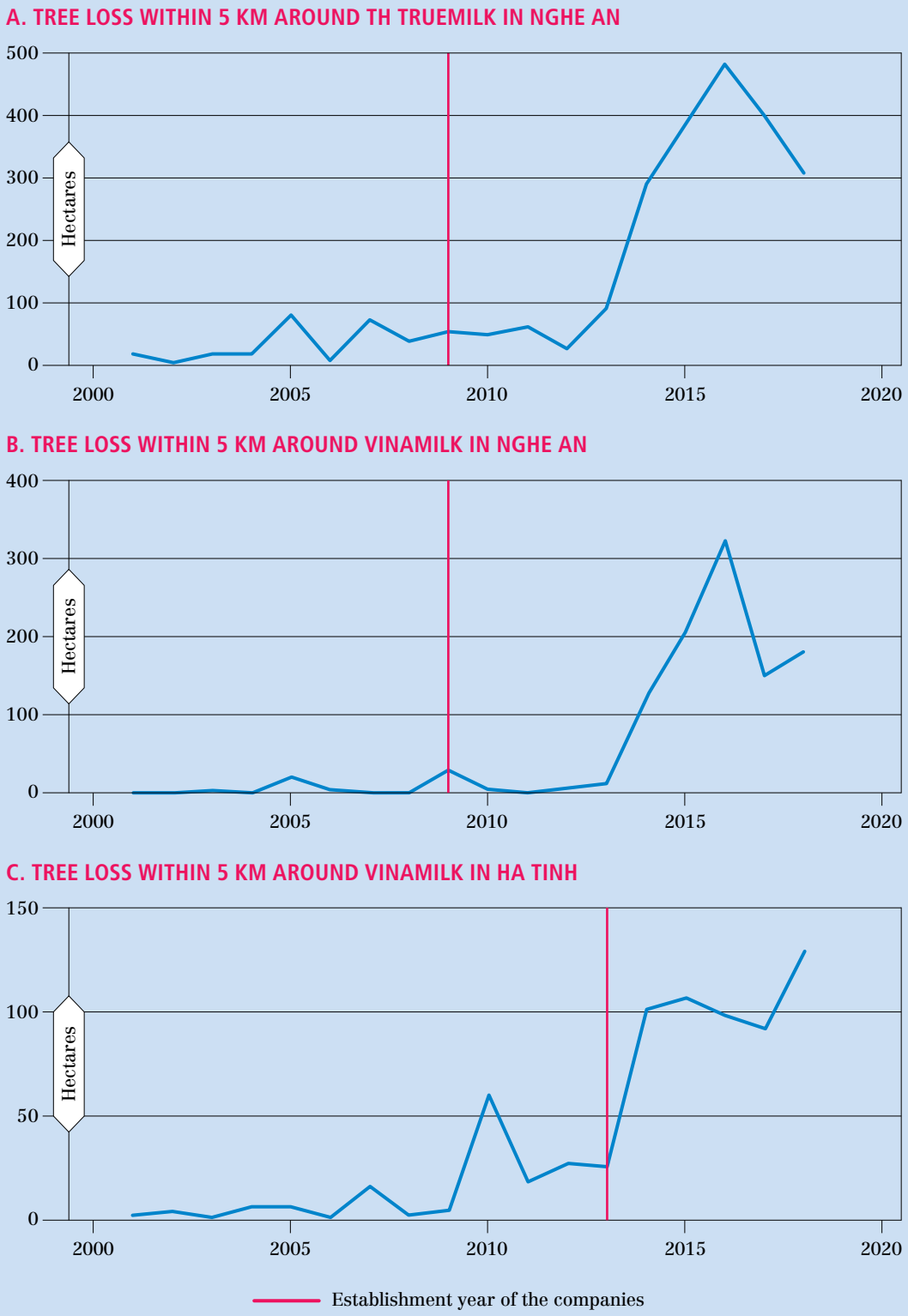
BOX 7 Establishment of large dairy companies and tree loss

An analysis of the tree loss in the surroundings of the dairy companies in recent decades shows that after their establishment substantial deforestation occurred. Even though causality was not established, the dairy companies might have played a role in it. In the five km radius around TH TrueMilk company in Nghe An, between 2012 and 2016 a tree loss of almost 500 ha occurred (see Figure 26). Similarly, a tree loss of about 300 ha took place around Vinamilk farm (*"trang trai"*) in Nghe An between 2009 and 2016, and of about 100 ha around Vinamilk farm in Ha Tinh after 2013/14.

[45] See Section 2 for more details on land use constraints within agriculture and links to deforestation.

BOX 7 (cont.) Establishment of large dairy companies and tree loss

FIGURE 26 Tree loss in the 5 km-ray around dairy companies in Nghe An and Ha Tinh



Source: Authors' own elaboration.

6 Conclusions and recommendations

Viet Nam has achieved remarkable progress in reversing the negative trends in forest cover change. Yet, over two-thirds of natural forests are considered to be of low quality, low-land forests have been completely depleted, and the country still experiences deforestation, forest degradation and fragmentation with one of the world's highest rates of primary forest deforestation. Agriculture continues to play a key role in deforestation and decision-makers must promote deforestation-free agriculture sector development paths. The Government of Viet Nam has a challenging task at hand, as agriculture sector development cannot rely anymore on simple production expansion and must involve increasing the quality and value added of its products, while ensuring better forest protection.

Beef and dairy sectors development face a particularly challenging future. Both are expanding at a rapid pace and will continue to do so, given the shift in consumer preferences and governments' efforts to promote their development, which will unavoidably require devoting additional land to expanding beef and dairy farms and for production of feed. Yet, the additional land is not bound to come at the cost of deforestation if a number of key policy reforms and investments take place. The policy and investment mix will require a combination of general agriculture sector-related actions and those specifically targeted to beef and dairy sectors.

The general orientation of agriculture sector development should consider:

- **Easing constraints on agricultural land to allow moving from low value to higher value commodities, such as production of beef and dairy, on existing agricultural land**

  This will require the removal of agricultural land use restrictions to allow farmers freely choose the commodity to produce and respond to market signals – such as increased demand for feed crops – within existing agricultural land. Land size limits currently in place that restrict plot sizes should be removed to allow for land consolidation and create economies of scale. It will also require ensuring that land use rights are properly enforced, and all farmers have received their land use certificates, while compulsory land conversions, still taking place, are limited and if they happen, farmers are compensated at market prices. Finally, ensuring transparency in land management will be key to reducing the risk of corruption and avoiding the illegal acquisition of land.

- **Improving the availability and access to credit**

  Investing in modern and efficient farming technologies that are necessary for increasing yields and value addition, requires substantial financial resources. Easing access and availability to credit would help the farmers to undertake such investments. This is particularly important for the smallholder farmers and other microbusinesses involved in the agricultural value chains that often lack the capital to invest. Credit for improving the production and processing of agricultural commodities would help to increase quality and productivity within the existing limits of agricultural land.

- **Improving rural education, training and extension services, including re-orientation towards improving farm management skills**

  Such investments are key to ensure farmers and other businesses in the agricultural value chains can fully benefit from existing technologies to improve their production and processing systems.

- **Enhancing labour mobility across sectors and across regions to support production and income diversification and structural transformation**

  Structural transformation of the agricultural sector towards more modern, productive and yielding high-quality products will require some of less competitive producers and businesses to drop out of the sector. It is key to allow the laid-off labour to find jobs outside the sector. It is particularly important to allow the labour to move freely across various sectors and invest in providing new employment opportunities both in urban and rural areas. New job opportunities will also increase income diversification opportunities for family farms that will remain in business, allowing them to invest in increasing further their competitiveness.

- **Promoting the creation of farm cooperatives and strengthening the existing ones**

  Farm cooperatives may bring a wide range of benefits to their members, encompassing creating economies of scale, improving market position both in input and output markets, sharing knowledge and improving the technology of production, among others.

- **Improving the availability and access to market information systems**

  Smallholders have typically inadequate information on prices and demand for their produce. In many agricultural sectors, including beef, smallholder farmers rely exclusively on information coming from neighbours or by-passing traders, which significantly limits their chances to harness existing market opportunities.

- **Improving linkages between various stages of commodity value chains including increased use of formal contracts and reducing information asymmetry between different actors**

  Strengthening and promoting the use of formal contracts secures the revenues of sellers and ensures that buyers have access to the demanded goods in a timely manner. This allows for increased efficiency at each stage of the value chain through better planning, reduction of waste and secured earnings.

- **Reinforcing existing legislation and regulations to protect forests**

  Adequate environmental regulations, reinforced monitoring, compliance and enforcement of the legislation remains a key element in protecting the remaining forests. Further, forest management could be improved through better collaboration between central, province and local government layers and transparent allocation of rights to forest land. Any investments that alter existing landscapes should be subject to environmental assessments to reduce impact on forest cover change. In particular, any major investments in infrastructure such as roads, processing plants or physical markets should be evaluated from the perspective of current and possible future impacts on the surrounding environment.

  Beef and dairy sectors specific orientation should consider:

- **Ensuring that the production increases are achieved through productivity improvements rather than the creation of new beef and dairy farms**

  Further increases in beef production may be only achieved through farm modernization and restructuration that would enhance their productivity. To avoid deforestation, this must be done within the existing limits of agricultural land. The growing demand for beef has created an opportunity for a shift from traditional extensive livestock farming to semi-intensive and intensive systems and larger production scales. The government must ensure that this transition takes place, but at the same time the unavoidable intensification is not creating a new source of pressure on land use that might lead to deforestation. This is already the case for dairy, where the efficient and modern systems are already in place, yet they require continuously increasing amounts of feed.

Further increases in dairy production may lead to establishing new dairy farms (or expanding the size of existing ones), as the existing farms are already modern and highly efficient with little room for improvement in productivity. It is critical to ensure that if new dairy farms are established, this happens through conversion of existing farms into dairy producing businesses. The government should also invest in agricultural research and innovation to search for new technologies that would allow to increase the existing productivity frontier for the existing dairy farms.

- **Ensuring that increasing demand for feed is met by production within existing agricultural land**

  Demand for feed has been growing and is likely to continue to grow in the future. Given the existing price incentives to produce many of the crops used for feed and the strong demand, the domestic production of feed will continue to expand. It is key to reform the agriculture sector along the lines outlined in the general recommendations to allow farmers to respond to the demand within the existing agricultural land. Further, removing the existing price incentives that make domestic production of feed attractive would reduce the supply response and increase reliance on imported feed.

- **Enhance the development of appropriate processing infrastructure and promote the use of cold chain**

  Investments in the development of appropriate processing infrastructure, including modern, mechanized slaughterhouses with adequate cooling facilities, will be key to harness the growing market opportunities. This should be accompanied by reinforcing compliance with food safety standards and promoting consumer awareness on the importance of buying only those products that meet the food safety standards. COVID-19 has exposed fully the risks of consuming unsafe food; it is key to reinforce regulations as well as their enforcement and accompany them with adequate investments to reduce future risks of food-borne diseases to the minimum.

- **Enhance the role of international trade**

  The growing consumer demand and the policies in place create favourable conditions for the expansion of the beef and dairy sectors. Yet, even if all structural reforms take place, it is highly unlikely that the future growth of demand can be completely satisfied with domestic production. Similarly, the continuously growing demand for feed cannot be met only through domestic production increases. As a result, it is key to ensure that international trade plays a central role in covering the required supplies.

  Increased exposure to international trade will not only reduce domestic production pressures, and hence pressures on acquiring additional land, but also has the potential to enhance knowledge sharing and technology transfer, increase competition and competitiveness of domestic producers while stimulating increasing quality of products. The government should continue policy reforms (domestic and trade) to allow greater trade openness. Reducing and subsequently eliminating existing price distortions should be the first step in this direction.

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Annexes

Annex 1. Methodological note

The methodology of this study relies on a holistic mixed-methods approach developed for the scope of the present study, which combines a descriptive analysis of forest cover trends and cow rearing in the provinces; an empirical analysis of the correlation between cow rearing and tree cover loss at the commune level; and a value chain analysis for dairy and beef sectors in the selected provinces to unpack the potential channels of impact.

The approach integrates qualitative information from secondary sources, secondary data from various national and international sources, and observational data from field interviews.

The initial set of information derives from an in-depth literature review of reports, bulletins, briefs, scientific papers and policy notes. The analysis has been built on this background using a set of quantitative information on the level of forest cover and agricultural activities, merged in a unique commune-level panel. More specifically, forest cover information derives from multiple sources, including a mix of satellite data (Global Forest Watch platform based on Hansen *et al.*, 2013) and a set of data delivered by local institutions (General Statistics Office) and the Ministry of Agriculture and Rural Development. Agricultural and socioeconomic data include survey data provided by local institutions, such as the Rural, Agriculture, and Fishery Census, and a set of geospatial databases including, among others, distance from roads and population density from Worldpop.

Next, the secondary data have been integrated with observational data obtained through field interviews. Qualitative and quantitative information has been collected by a local consultant who conducted field visits in the two provinces during the period 8–20 October 2020 (Annex 7 details the stakeholders interviewed). One set of the interviews was based on a series of predetermined open-ended questions directed to a large number of actors operating across the two value chains and validated by experts and local institutions. The actors have included, among others, the Central, Provincial and District Departments of Forest Protection; the Department of Crop Cultivation and Plant Protection; the Forest Protection Research Centre; donors (including Japan International Cooperation Agency, JICA) who deal with forest management and protection, and agricultural development; cow breeding companies; dairy companies (Vinamilk, TH TrueMilk); various farmer associations (Ruminant Husbandry Association, Dairy Association); and local livestock officials and experts of the value chains. In the second set of interviews, the consultant conducted a non-representative quantitative survey with the support of Survey Solution on a set of 35 farmer households, of which six holding dairy cows and 29 holding beef cows.

Some important data limitations have reduced the scope of the present study. Whenever possible, these limitations have been addressed, at the best of possibilities. The first key gap consists in the unavailability of time varying geo-localized forest cover data containing specific information on the types of trees, and particularly distinguishing between planted or natural forests. The necessary information could have been available using the National Forest Inventory and Monitoring Programme (NFIMAP) data and VNForest data, yet only few data points for major administrative levels were made available, while it was not possible to gain access to the full set of refined spatial data during the time of writing this study.[1]

[1] It was particularly challenging to link with the Forest Inventory and Planning Institute (FIPI) and with the Forest Protection Department who have developed this data.

As a result, it was impossible to understand whether the observed tree loss was linked to planted forests or natural forests. The use of the tree cover loss indicator derived from Hansen *et al.* (2013) may overestimate deforestation, as tree cover data includes tree plantations and agricultural tree crops and may also include harvesting cycles of plantations. However, plantation harvests made up only 8 percent of all tropical tree cover loss from 2013 to 2019 (Harris, Goldman and Gibbes, 2019), indicating that the overestimation is likely to be marginal. Moreover, available data did not allow the econometric design considerations, which would be required to establish causality between cow rearing for beef and dairy and deforestation.

A second limitation relies on the unavailability of secondary data information on the value chains under analysis. In particular, while the census data provide a general picture of the agricultural situation, it lacks specific figures on overall agricultural income, income by typology of production, costs of inputs used, and trading. These limitations have been addressed by designing (non-representative) quantitative and qualitative surveys conducted among a set of farmers and actors operating in the two selected provinces. Although these surveys have involved a limited number of respondents, these figures have been confirmed by one-to-one discussions with other stakeholders and supported by additional secondary data when available.

Annex 2. Viet Nam: main economic indicators

TABLE A1 Viet Nam: main economic indicators

	2000	2010	2018
GDP (current billion VND)	441 646	2 157 828	5 542 332
GDP (constant 2010 billion VND)	1 138 111	2 157 828	3 493 399
GDP (current million USD)	31 173	115 932	245 214
GDP (constant 2010 million USD)	61 146	115 932	187 687
GDP per capita (constant 2010 VND)	14 242 337	24 529 790	36 564 628
GDP per capita (constant 2010 USD)	765.19	1 317.89	1 964.48
Agricultural GDP (current billion VND)	108 356	396 576	813 724
Agricultural GDP (constant 2010 billion VND)	282 541	396 576	500 567
Agricultural GDP (current million USD)	7 648	21 306	36 002
Agricultural GDP (constant 2010 million USD)	15 180	21 306	26 894
Share of agriculture in GDP (%)	24.5	18.4	14.7
Share of employment in agriculture (%)	65.3	48.7	38.6
Population	79 910 412	87 967 651	95 540 395
Population density	257	284	308
Land area (km^2)	311 060	310 070	310 070
Agricultural land (km^2)	87 800	107 601	121 780
Share of agricultural land (%)	28.2	34.7	39.3

Source: World Bank. 2020. *World Development Indicators*. Washington, DC. Cited 15 November 2021. https://databank.worldbank.org/source/world-development-indicators

Annex 3. Forest definitions and classifications

The Global Forest Resource Assessment (FAO, 2020) adopts the following definition of forests:

> Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use. […] It excludes tree stands in agricultural production systems, such as fruit tree plantations, oil palm plantations, olive orchards and agroforestry systems when crops are grown under tree cover. […] It includes rubber-wood forests.

Further, forests are classified into the following categories (FAO, 2020):

- **Naturally regenerating forest:** forest predominantly composed of trees established through natural regeneration.
  - **Primary forest:** naturally regenerated forest of native tree species, where there are no clearly visible indications of human activities, and the ecological processes are not significantly disturbed.
- **Planted forest:** forest predominantly composed of trees established through planting and/or deliberate seeding. Planted forests, therefore, are identified by the occurrence of human intervention for their inception and management, which varies depending on the type of intervention and on the objectives for their establishment. For this reason, the distinction between planted forests and semi-natural forests, characterized by limited human intervention, is often arbitrary and depends on silvicultural practices applied in varying levels of forest management (FAO, 2000). Planted forests may consist both of exotic introduced species or intensively managed plants of indigenous species. According to FAO (2000), the latter are often composed of one or two species at planting, have all a similar age class and are planted with regular spacing.
  - **Plantation forest:** planted forest that is intensively managed and meets all the following criteria at planting and stand maturity: one or two species, even age class, and regular spacing.
  - **Other planted forest**.

In Viet Nam, forests are identified and classified according to the Ministry of Agriculture and Rural Development's Circular No. 34/2009/TT-BNNPTNT dated 10 June 2009. Three criteria, in line with FAO definition, identify and define forests as: minimum 10 percent of tree cover, at a minimum height of 5 meters, over a minimum area of 0.5 ha.

Different classifications exist depending on the origin and function of forests.

By origin, forests are classified into natural and planted forests:

- **Natural forests:** forests are available in nature or restored by natural regeneration, including primary and secondary forests.
- **Planted forests:** refer to forests that are planted by humans, including new plantations on land without forests; replanted forests after timber harvest of existing planted forests, naturally regenerating forests from harvested planted forests.

By function, forests are classified into protection, special-use and production forests:

- **Protection forests:** forests are mainly used to protect water resources, protect land, prevent erosion, combat desertification, limit disasters, regulate climate and protect the environment.

- **Special-use forests:** forests are mainly used for nature conservation, the standard sample of the national ecosystem, and forest genetic resources; scientific research; protection of historical and cultural relics, tourist attraction; serve for rest and tourism, combined with environmental protection.
- **Production forests:** forests are mainly used for the production and trading of timber, and non-timber forest products, combined with purposes of protection and environmental protection.

Based on Circular No. 34 of 2009, a 17-land uses classification system was developed in 2010, including 12 forest types (see Table A2).

TABLE A2 Land-use classification system based on Circular No. 34 of 2009

	Land type	Forest/non-forest	Remarks
1	Evergreen broadleaf - rich forest	Forest	Average timber stock >200 m³/ha
2	Evergreen broadleaf - medium forest	Forest	Average timber stock 100–200 m³/ha
3	Evergreen broadleaf - poor forest	Forest	Average timber stock <100 m³/ha
4	Evergreen broadleaf - regrowth forest	Forest	
5	Deciduous forest	Forest	
6	Bamboo forest	Forest	
7	Mixed timber and bamboo forest	Forest	
8	Coniferous forest	Forest	
9	Mixed broadleaf-coniferous forest	Forest	
10	Mangrove forest	Forest	
11	Limestone forest	Forest	
12	Plantation	Forest	
13	Limestone without trees	Non-forest	
14	Bare land	Non-forest	
15	Waterbody	Non-forest	
16	Residential	Non-forest	
17	Other land	Non-forest	

Source: MARD. 2016. *Viet Nam's Modified Submission on Reference Levels for REDD+ Results Based Payments under UNFCCC.* Hanoi.

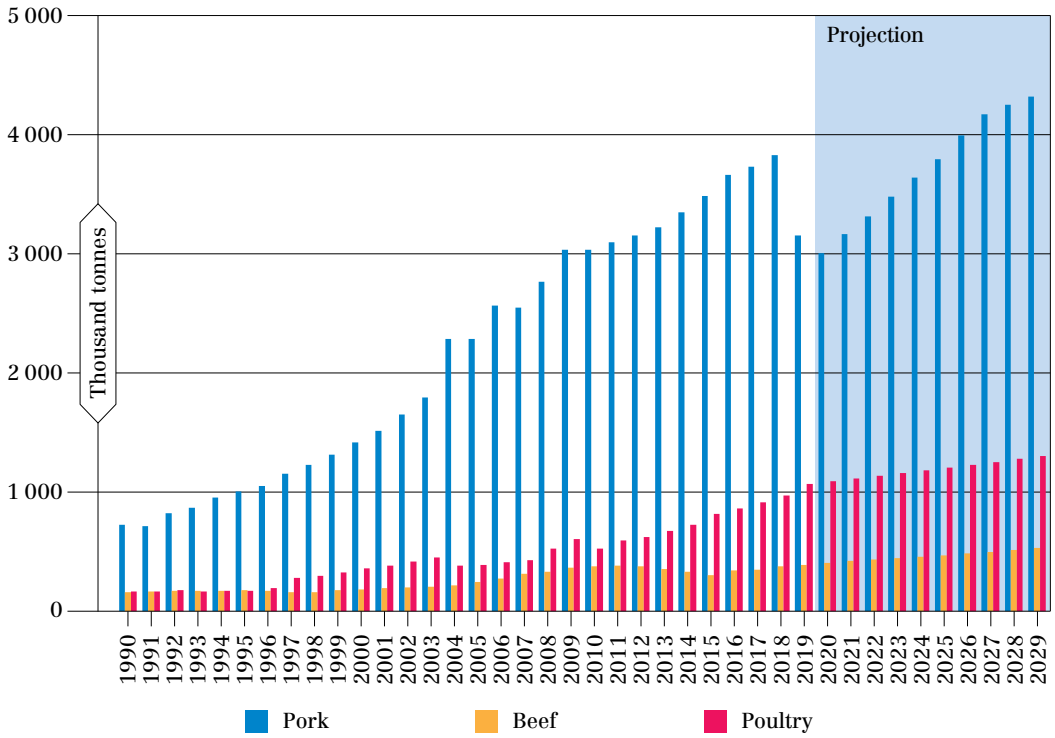
Annex 4. Meat and dairy sectors in Viet Nam: production and consumption trends, and trade patterns

Meat production and consumption in Viet Nam

Meat production in Viet Nam is overwhelmed by pork, followed by poultry and eventually by beef (see Figure A1). They contribute to 68, 23 and 8 percent of meat production respectively (corresponding to 3 160 000, 1 069 000 and 392 000 tonnes). Beef production grew considerably less than pork and poultry in the period 1990–2019 (+3 percent), with the latter exhibiting a 5–6 percent average annual growth (OECD and FAO, 2020).

Pork consumption figures suggest that internal production largely satisfies the country's demand for pork, while this does not appear to be true for poultry and beef (see Figure A1). Meat consumption data for the year 2019 (see Table A3) show that beef[2] per capita consumption (8.1 kg) comes after that of pork and poultry (26 and 16.2 kg respectively).

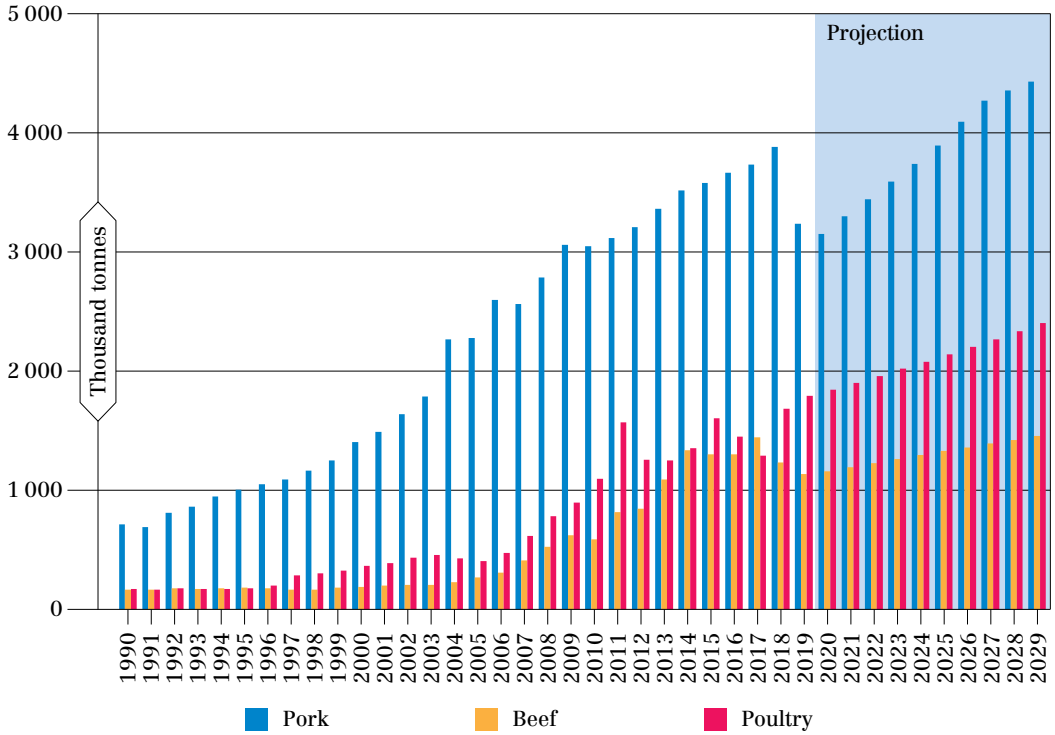
FIGURE A1 Historical meat production in Viet Nam, 2009–2019 and 2029 projections



Source: OECD & FAO. 2020. *Agricultural Outlook 2020–2029*. OECD Publishing, Paris and FAO, Rome. Cited 21 September 2021. https://doi.org/10.1787/1112c23b-en

[2] It also includes veal consumption.

FIGURE A2 Historical meat consumption in Viet Nam, 2009–2019 and 2029 projections



Source: OECD & FAO. 2020. *Agricultural Outlook 2020–2029*. OECD Publishing, Paris and FAO, Rome. Cited 21 September 2021. https://doi.org/10.1787/1112c23b-en

TABLE A3 Meat consumption in Viet Nam, 2019

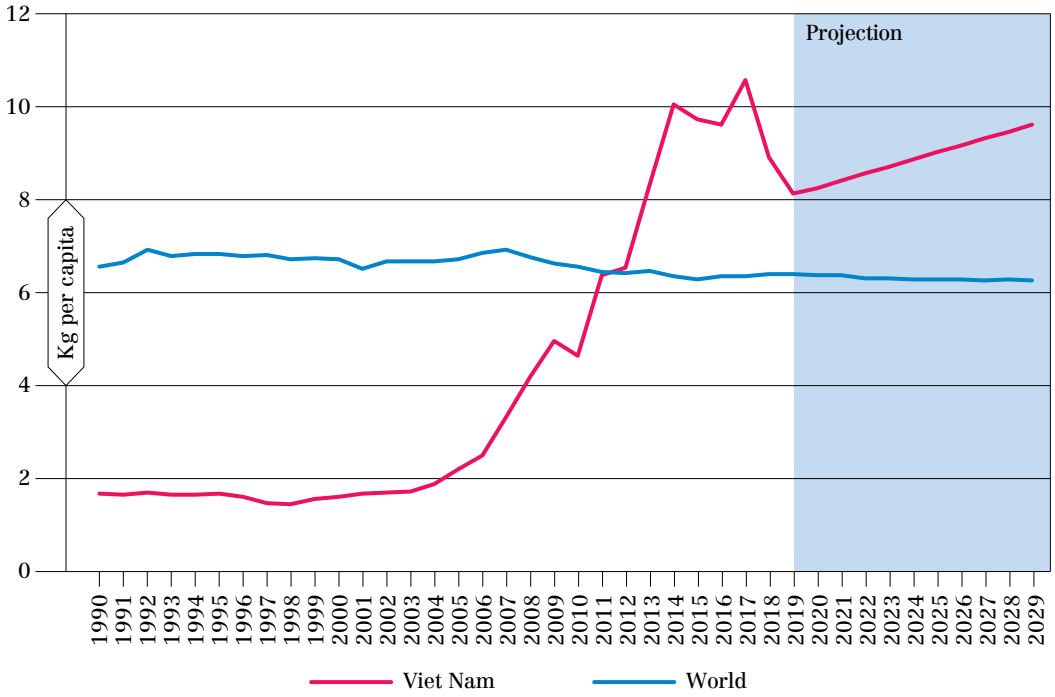
	Kg/per capita/year	Thousand tonnes	Rank	Share
Beef	8.1	1 134	3rd	18%
Pork	26	3 242	1st	53%
Poultry	16.2	1 795	2nd	29%
Total	50.3	6 170	–	100%

Source: OECD & FAO. 2020. *Agricultural Outlook 2020–2029*. OECD Publishing, Paris and FAO, Rome. Cited 21 September 2021. https://doi.org/10.1787/1112c23b-en

Beef consumption

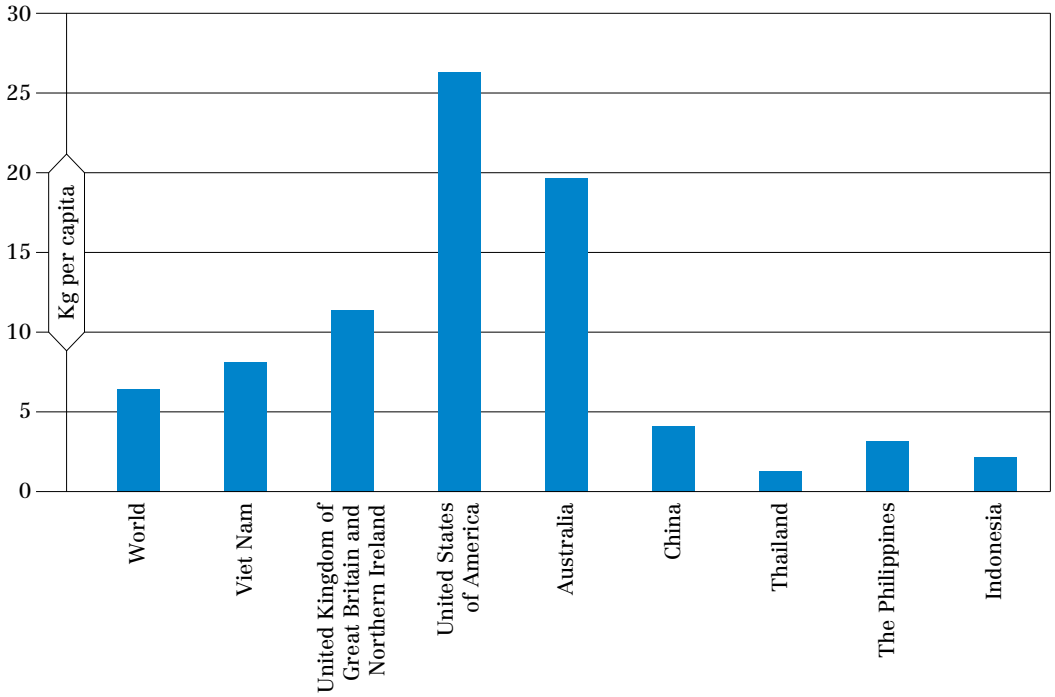
Since 2000 onwards, beef per capita consumption expanded at a rate of 9 percent per year on average. In the early 2000s, it was well below global average. Then the gap started to reduce, as growth accelerated, and since 2012, it has surpassed the world average. According to the OECD–FAO projections, in 2029 Viet Nam will consume about 33 percent more beef than the world average (9.6 versus 6.3 kilograms per capita respectively) (see Figure A3). In comparison with other countries, beef consumption per capita is, and will be, much closer to that of the United Kingdom of Great Britain and Northern Ireland, the United States of America and Australia, than to that of other regional peers including China, Thailand, the Philippines and Indonesia (see Figure A4).

FIGURE A3 Historical beef consumption in Viet Nam vs World average, 1990–2019 and 2029 projections



Source: OECD & FAO. 2020. *Agricultural Outlook 2020–2029*. OECD Publishing, Paris and FAO, Rome. Cited 21 September 2021. https://doi.org/10.1787/1112c23b-en

FIGURE A4 Beef consumption worldwide, 2019

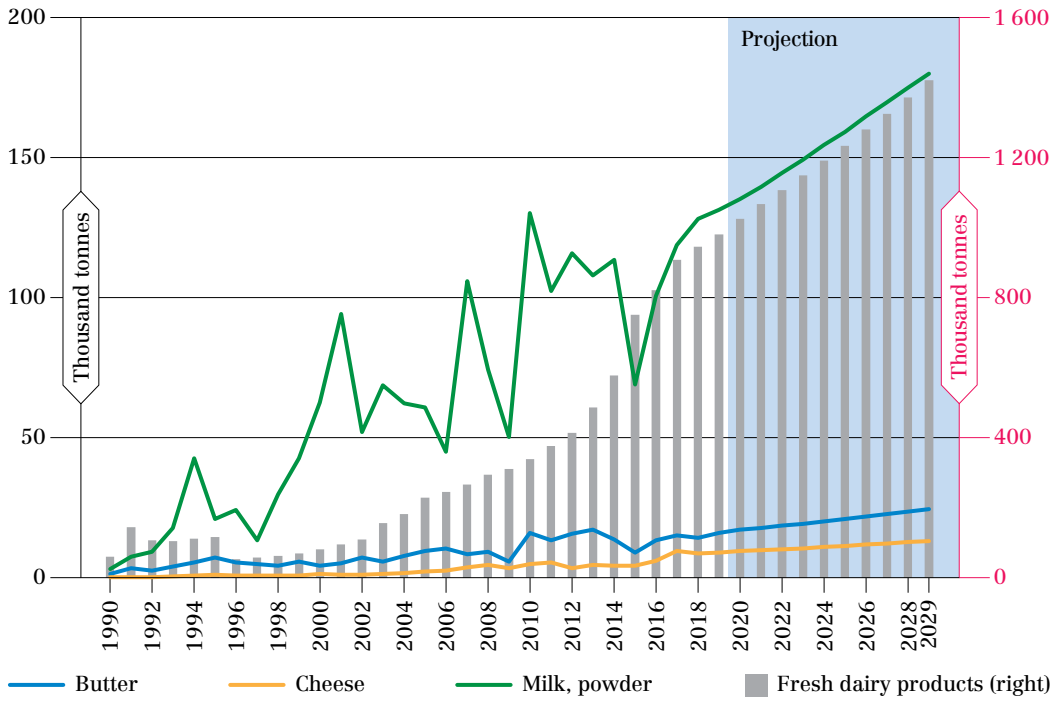


Source: OECD & FAO. 2020. *Agricultural Outlook 2020–2029*. OECD Publishing, Paris and FAO, Rome. Cited 21 September 2021. https://doi.org/10.1787/1112c23b-en

Dairy consumption

Dairy consumption substantially increased in the last decade (see Figure A5). Consumption of fresh dairy products expanded from 311 000 to 981 000 tonnes in the period 2009–2019, expected to further grow up to 1 422 000 tonnes by 2029. Consumption of milk powder reached 131 000 tonnes in 2019, and according to projections, it will reach 180 000 tonnes in 2029. Consumption of cheese and butter respectively amounted to 16 000 and 9 000 tonnes in 2019, and it is expected to slightly increase by 2029. Predictions for the dairy sector indicate that consumption will steadily grow up to 1 640 000 tonnes.

FIGURE A5 Historical dairy consumption in Viet Nam, 1990–2019 and 2029 projections



Source: OECD & FAO. 2020. *Agricultural Outlook 2020–2029*. OECD Publishing, Paris and FAO, Rome. Cited 21 September 2021. https://doi.org/10.1787/1112c23b-en

Beef trade

Viet Nam trades live cattle as well as fresh and frozen meat. Live cattle trade is larger than that of meat both in terms of value and quantity (see Figures A6 and A7). Within the beef meat trade, the fresh meat sector is the least developed, showing very low traded quantities. Frozen bovine meat trade flows are greater and generally growing.

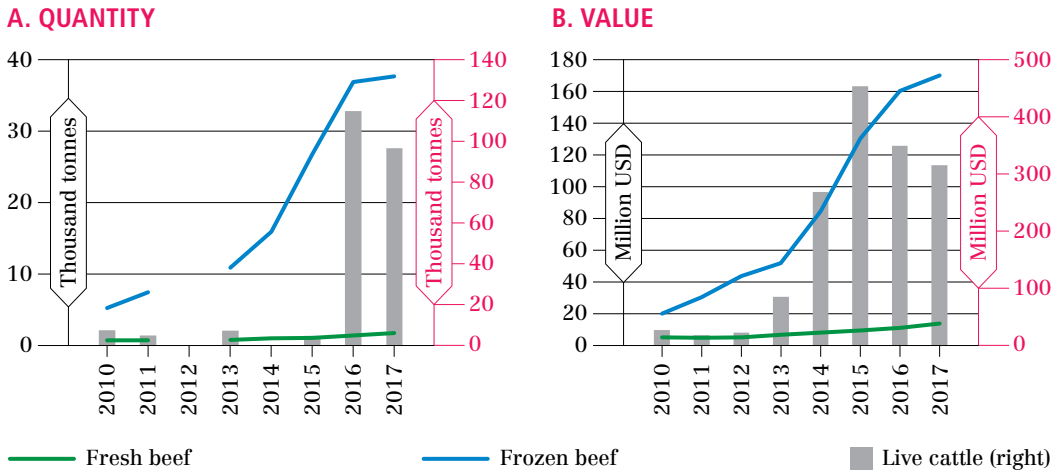
As a general trend, imports are much greater than exports, characterizing Viet Nam as a net importer country of beef. Live bovine imports were worth USD 316 million in 2017, compared to frozen and fresh beef meat imports' value of USD 170 and 14 million. Concerning exports, live bovine export value almost equals frozen beef export value (USD 3.2 and 3 million respectively), but in decline after a peak of USD 25 million in 2015. Fresh beef export value is insignificant.

The trend of imports is broadly positive for all three commodities. Live cattle import value surged between 2012 and 2015, from USD 23 to 454 million, and then slightly decreased until 2017, reaching USD 316 million. Frozen beef import value shows a more stable increasing

trend since 2010, growing from USD 20 to 170 million. Fresh beef import value slightly and constantly increased in the period 2010–2017 from USD 5 to 14 million. The general import surge in recent years is mostly driven by the increasing domestic demand and constrained domestic production. Domestic demand is in turn backed by macro drivers such as growing disposable incomes, population growth and urbanization. Imports increase is also related to an increase in demand for high quality beef, mainly in Ho Chi Minh, Hanoi and other large cities (also in relation with tourism).

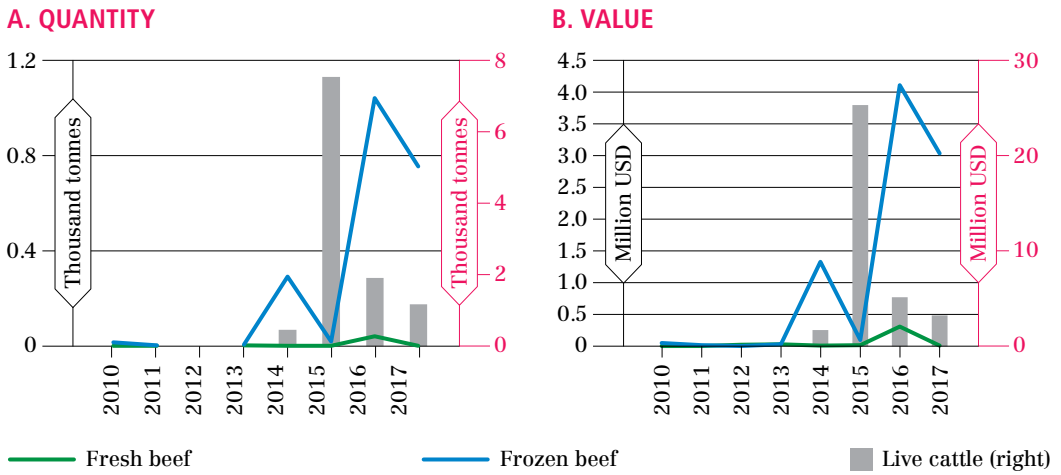
The export trend is rather fluctuating. Live cattle export value jumped from USD 1.7 to 25 million from 2014 to 2015, then down to USD 5 and 3.2 million in 2016 and 2017. Frozen beef export value reached USD 1.3 million in 2014, and after a decline in 2015 it reached USD 4 million in 2016 and fell again to USD 3 million in 2017. Export growth is mainly related to China's increasing internal demand for beef in recent years.

FIGURE A6 Live cattle and beef imports in Viet Nam, 2010–2017



Source: United Nations. 2020. *UN Comtrade Database*. New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

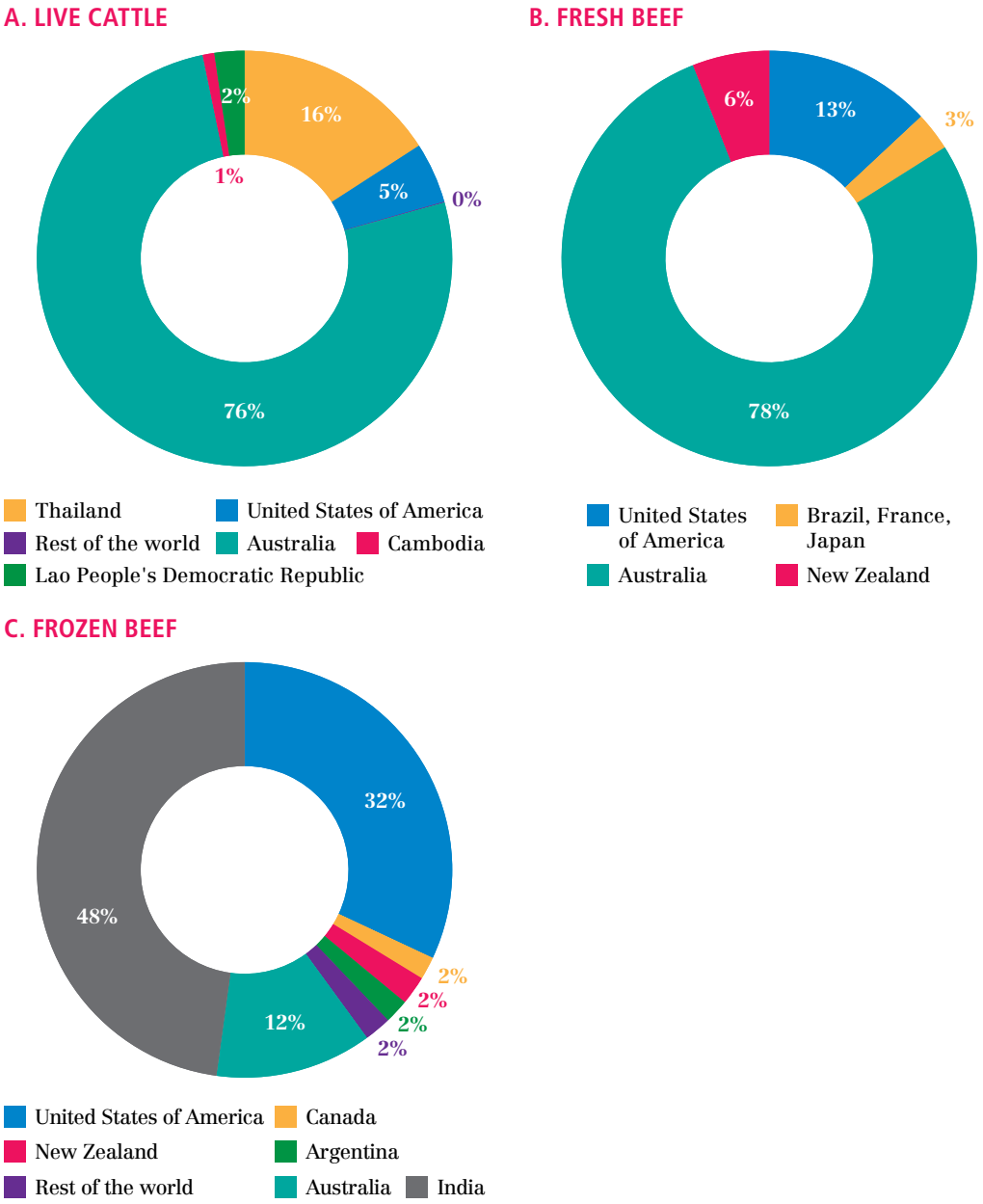
FIGURE A7 Live cattle and beef exports in Viet Nam, 2010–2017



Source: United Nations. 2020. *UN Comtrade Database*. New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

Australia is the main import partner of Viet Nam (see Figure A8). Imports of live cattle come mainly from Australia (76 percent), Thailand (16 percent), the United States of America (5 percent), the Lao People's Democratic Republic (2 percent) and Cambodia (1 percent). Fresh beef meat is largely imported from Australia (78 percent), the United States of America (13 percent) and New Zealand (6 percent). Frozen beef meat originates from India (48 percent), the United States of America (32 percent) and Australia (12 percent). The different import source countries likely reflect the distinct markets their produce is destined to. Imports originating from Australia and the United States of America, enter in the high value market segment, while imports from the Lao People's Democratic Republic, Cambodia and Thailand are destined to the lower value markets.

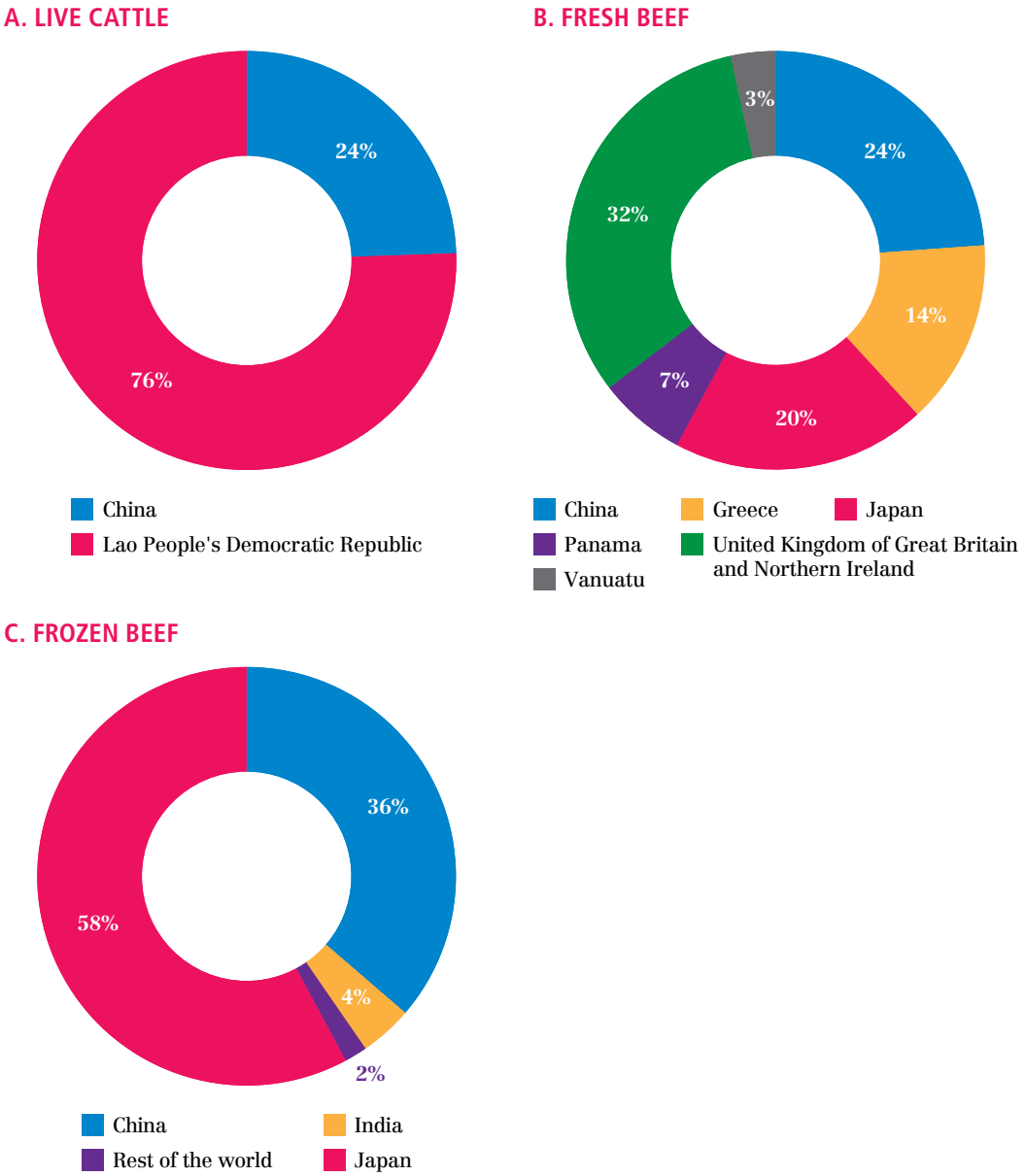
FIGURE A8 Live cattle and beef import value by partner country, 2017



Source: United Nations. 2020. *UN Comtrade Database*. New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

Export destination countries vary according to the product (see Figure A9). Live cattle are mostly shipped to the Lao People's Democratic Republic (78 percent) and China (24 percent); fresh beef meat is destined to the United Kingdom of Great Britain and Northern Ireland (32 percent), China (24 percent), Japan (20 percent) and Greece (14 percent); frozen beef meat is destined to Japan (58 percent) and to China (36 percent).

FIGURE A9 Live cattle and beef export value by partner country, 2017

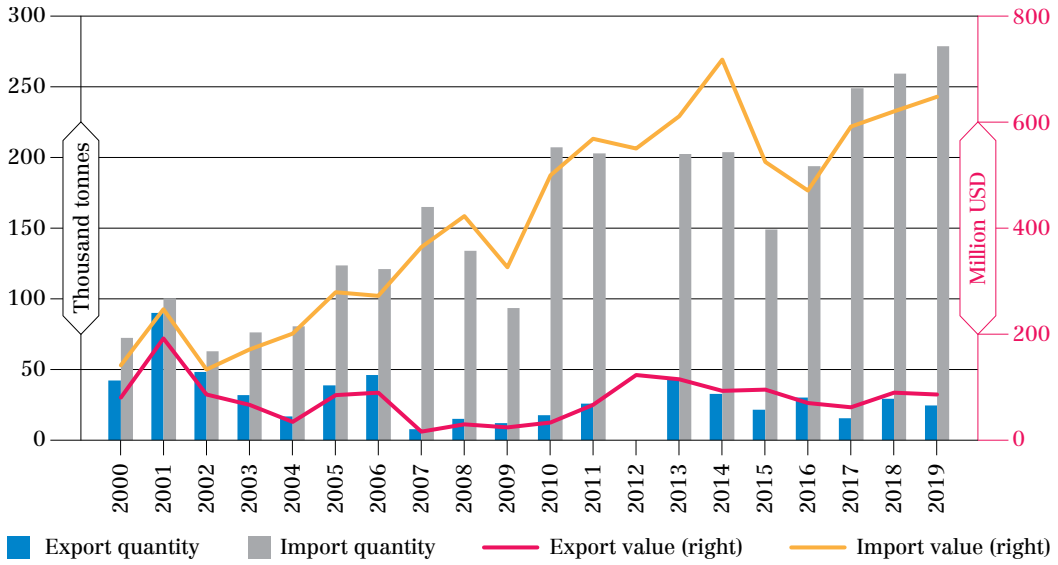


Source: United Nations. 2020. *UN Comtrade Database*. New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

Dairy trade

Viet Nam's dairy trade balance has been negative from the 2000s onwards, with the import-export gap substantially widening throughout the period (in 2019 exports were only the 13 percent of imports value). This is explained by the need of imports to backstop internal production during the sector's development, and to complement the growing internal demand for dairy products (see Figure A10). Dairy imports started in the early 2000s, and then remarkably expanded from 2009 onwards (from 94 000 to 279 000 tonnes), in correspondence with the period of expansion of the dairy industry. Yet exports followed a general decreasing trend (declining from 42 000 to 24 000 tonnes).

FIGURE A10 Dairy trade quantity and value in Viet Nam, 2000–2019



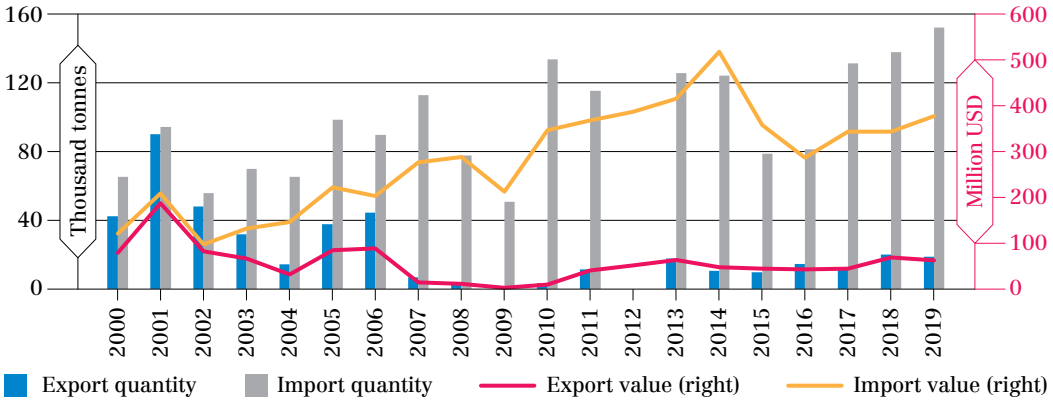
Source: United Nations. 2020. *UN Comtrade Database.* New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

The main dairy product involved in trade is powdered milk (see Figure A11). It accounts for a large share of total exports and imports: in 2019, powdered milk exports accounted for 77 percent of total exports, while powdered milk imports made up 55 percent of total imports. In the early 2000s, they were almost 100 percent of the trade flows. Powdered milk imports reached 152 000 tonnes in 2019, with a corresponding value of USD 649 million, more than doubling since the 2000s.

Besides powdered milk, dairy imports are mostly made up of milk (both fresh and condensed), butter[3] and cheese (see Figures A12 and A13). Fresh milk imports reached 42 000 tonnes in 2019, representing a 27 percent annual increase over the last decade, for a corresponding value of USD 36 million. Condensed milk imports account for a similar quantity (43 000 tonnes), but for a higher value of USD 64 million in 2019. They grew less over the past decade, being already 24 000 tonnes in 2009. Butter (including ghee) imports made up a smaller amount, being 17 000 tonnes in 2019, but having a larger value of about USD 100 million. Cheese imports have been following an increasing trend for the past decade (from 3 500 to 11 000 tonnes between 2009 and 2019), growing on average by 13 percent per year, and accounting for USD 52 million in 2019.

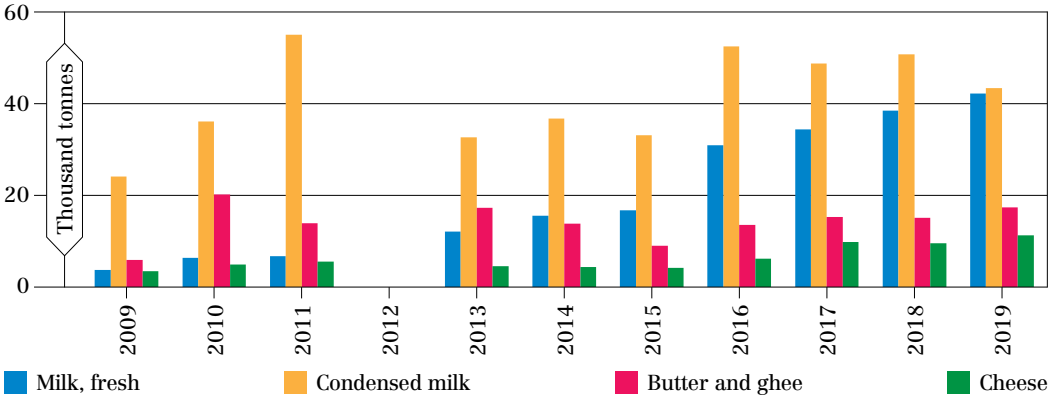
[3] Including butter, dairy spreads and ghee, as referring to the HS codes 40510, 40520 and 40590 (United Nations, 2020).

FIGURE A11 Powdered milk trade quantity and value in Viet Nam, 2000–2019



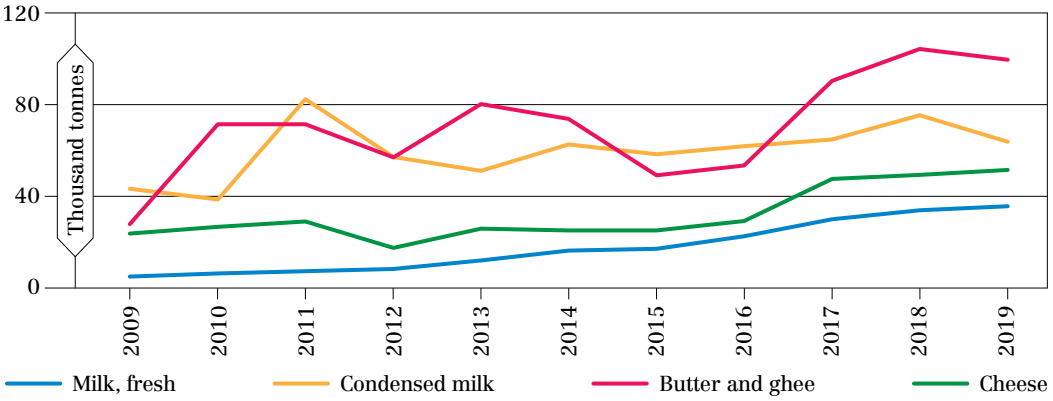
Source: United Nations. 2020. *UN Comtrade Database*. New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

FIGURE A12 Dairy import quantity (selected products) in Viet Nam, 2009–2019



Source: United Nations. 2020. *UN Comtrade Database*. New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

FIGURE A13 Dairy import value (selected products) in Viet Nam, 2009–2019

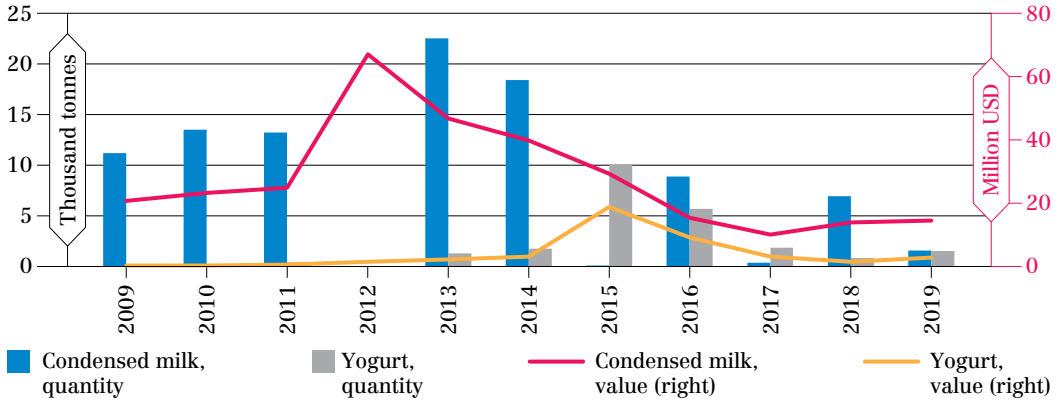


Source: United Nations. 2020. *UN Comtrade Database*. New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

Due to the domestic expansion of dairy consumption, dairy exports are very limited, even declining over the last few years (see Figure A14). Condensed milk and yoghurt are the main exported products. The respective exported quantities were 1 600 and 1 000 tonnes in 2019, for a corresponding value of USD 14 and 3 million.

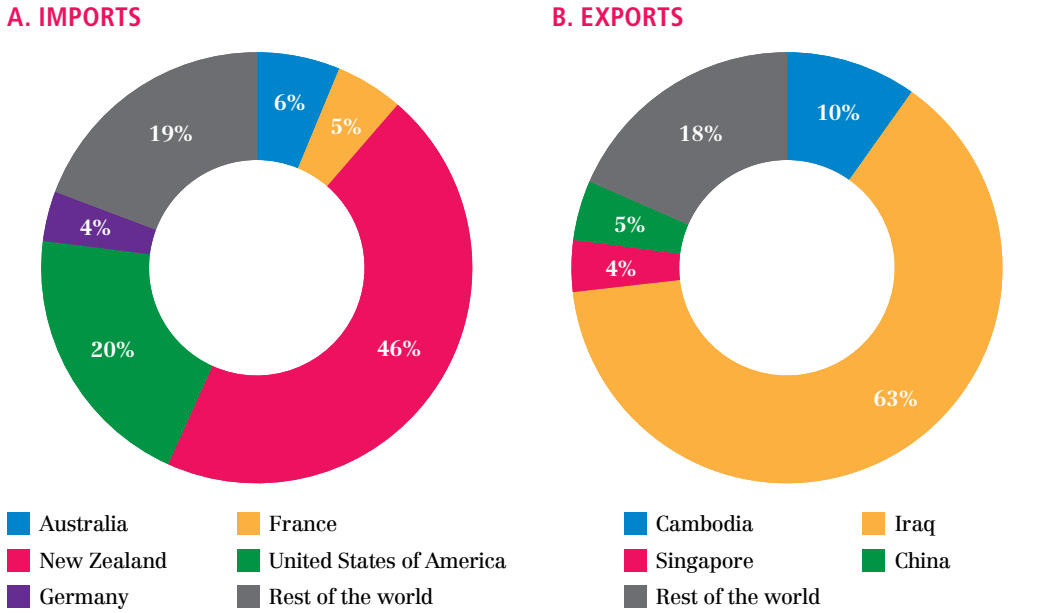
Trade partner countries differ according to the trade flow (see Figure A15). The main import partner is New Zealand (46 percent), followed by the United States of America (20 percent), and then by Australia, France and Germany (with 6, 5 and 4 percent respectively). The primary export partner is Iraq, to which the vast majority of exports is destined (63 percent), followed by Cambodia (10 percent), China (5 percent) and Singapore (4 percent).

FIGURE A14 Dairy export quantity and value (selected products) in Viet Nam, 2009–2019



Source: United Nations. 2020. *UN Comtrade Database.* New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

FIGURE A15 Dairy trade value by partner country, 2019



Source: United Nations. 2020. *UN Comtrade Database.* New York, USA. Cited 31 December 2020. https://comtrade.un.org/data

Annex 5. Empirical analysis: descriptive statistics

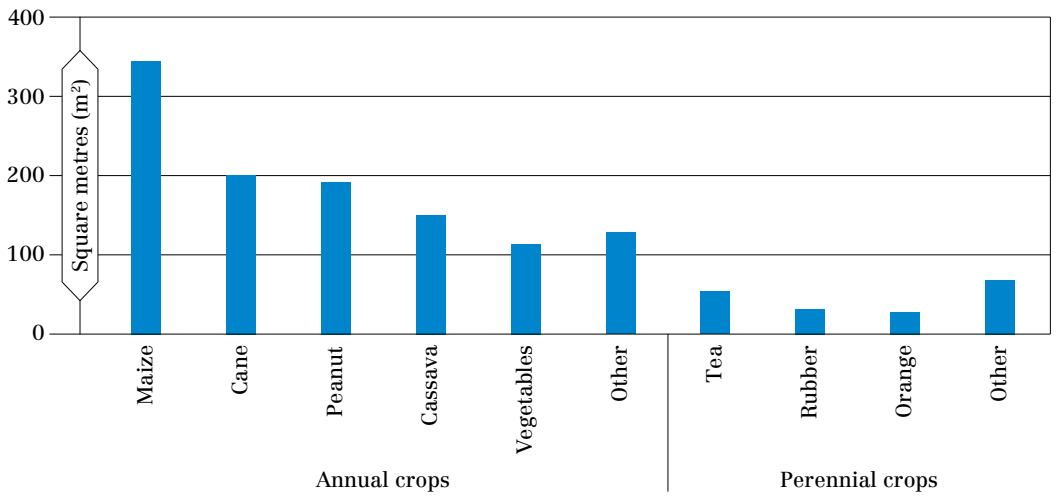
Profile of rural households in Nghe An and Ha Tinh

As often occurs with farmers holding limited land, the Vietnamese rural households are very likely to diversify and ensure their income by planting several crops. Besides rice, which occupies the largest area (2 533 m²/0.25 ha on average), the main cultivated crops are maize (346 m²), cane (201 m²), peanut (193 m²) and cassava (151 m²) (see Figure A16). Households with less than 0.2 ha of land show the lowest crop diversification due to the small amount of land they own, while those who own between 0.2 and 0.5 ha diversify the most.[4]

Besides crop cultivation, rural households are commonly involved in animal husbandry, owning few animals, as a safety net and for livelihood diversification. The majority of households (69 percent) own chickens, while 30 and 23 percent own cattle and pigs, respectively (GSO, 2016).

Low land endowments, combined with the reliance on agriculture as a primary source of living for the majority of households, may partially explain the underlying challenges that these rural households face to sustain their livelihoods.

FIGURE A16 Main crops (besides rice) cultivated in Nghe An and Ha Tinh by rural households, 2016



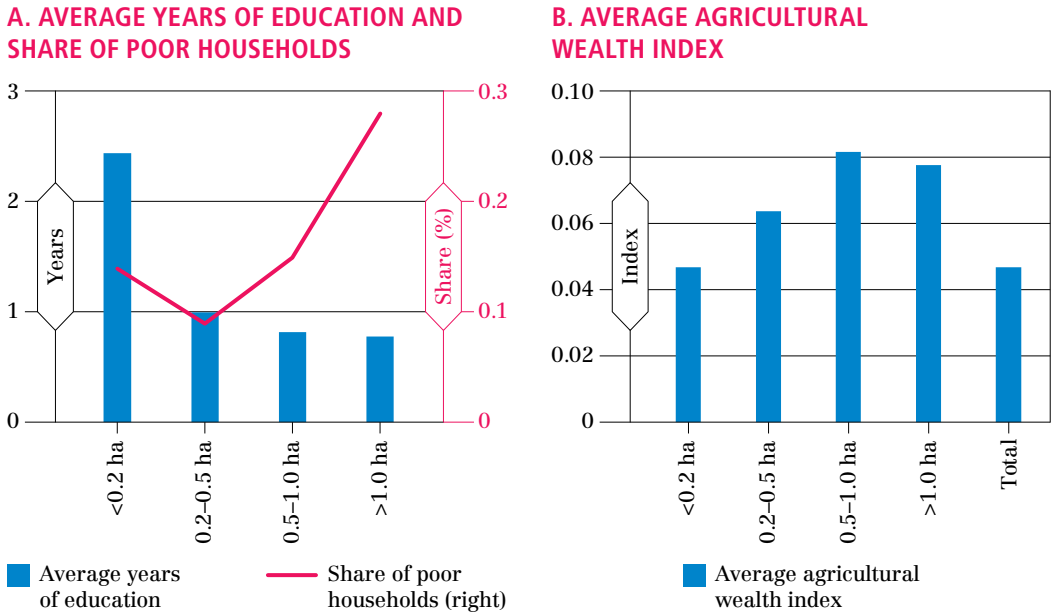
Source: GSO. 2016. *Rural, Agriculture and Fishery Census.* Hanoi.

According to census data, households with limited land size are also those with the lowest level of agricultural wealth.[5] Though, the larger the land endowments, the greater is the proportion of households classified as poor, and the lower are households' education attainments (see Figure A17). This may imply that households that are more invested in agriculture (and thus carry larger land endowments), are more susceptible to falling into poverty, perhaps due to the lower possibility of diversifying their labour and income, as they are generally less educated and more pulled by the agricultural sector due to their endowments.

[4] The former shows a Gini index of crop diversification equal to 0.4, while the latter of 0.7.

[5] As measured through a standardized principal component indicator computed on the ownership of a set of agricultural tools. The index ranges from 0 to 1, with higher values representing higher levels of wealth. See section on Research Design for more details.

FIGURE A17 Education, poverty and agricultural wealth index of rural households in Nghe An and Ha Tinh, 2016



Source: GSO. 2016. *Rural, Agriculture and Fishery Census.* Hanoi.

Taken together, this suggests that smallholders in Viet Nam are prevalent among the rural population and their level of agricultural wealth and labour supply may be too limited to endorse expensive or labour intensive sustainable agricultural strategies aimed at reducing deforestation.

Profile of cow rearing households in Nghe An and Ha Tinh

Census (RAFC) data, capturing cow rearing at the level of the rural households, may mostly refer to beef smallholder farmers,[6] however, they do not precisely state the purpose of cow ownership. Nevertheless, an analysis of cow rearing rural households could help identify potential connections between cows and deforestation.

Small-scale cow rearing is confirmed by census data, which show that almost all rural households involved in cow rearing hold less than ten cows – half (47 percent) having only one cow, half (52 percent) having between two and ten cows in 2016. RAFC data also indicate that an expansion towards the latter group has occurred between 2011 and 2016 (see Table A4), suggesting a very initial transition towards intensification, and confirming the expansion of the sector. An increase in the scale of production may also be suggested by the increase in the number of households with 10–500 cows, which more than doubled between 2011 and 2016, up to about 2 000 households, despite accounting for a very small share (1 percent).

Crossing cow ownership and land endowment data from the census (GSO, 2016) indicates that holding more cows and owning more land are positively correlated (see Table A5). Households with one cow typically have less than 0.5 ha of agricultural land; households with 2–10 cows tend to have slightly larger plots (not larger than one ha), while those who have more than 10 cows have access to land that is one ha or more.

[6] Dairy cattle are mostly in the hands of large dairy companies, not included in the census.

TABLE A4 Cow rearing households by the number of cows in Nghe An and Ha Tinh

	2011		2016	
	No. of households	Percentage (%)	No. of households	Percentage (%)
1 cow	164 812	61	140 193	47
2–10 cows	106 060	39	155 647	52
10+ cows	751	0.3	1 801	1
Total	271 623	100	297 641	100

Sources: GSO. 2011. *Rural, Agriculture and Fishery Census*. Hanoi; GSO. 2016. *Rural, Agriculture and Fishery Census*. Hanoi.

TABLE A5 Households by number of cows and amount of land owned, 2016

	<0.2 ha	0.2–0.5 ha	0.5–1 ha	>1 ha	Total
1 cow					
No. of households	42 078	67 963	16 501	13 651	140 193
Percentage (%)	30	48	12	10	100
2–10 cows					
No. of households	26 373	64 523	30 144	34 607	155 647
Percentage (%)	17	41	19	22	100
10+ cows					
No. of households	189	237	239	1 136	1 801
Percentage (%)	10	13	13	63	100

Source: GSO. 2016. *Rural, Agriculture and Fishery Census*. Hanoi.

Census data (GSO, 2016) also point to livelihood diversification of cow rearing households, in line with the general profile of rural households (at least at the provincial level). Besides cow rearing, they are also engaged in other agricultural activities such as the cultivation of rice, maize, cassava and other (see Figure A18). They are also involved in forestry and aquaculture activities, particularly those with a higher number of cows, and some also engage in non-farm activities outside the agricultural sector, for example, in construction.

Households with 2–10 cows own on average 0.9 ha of land, which is split between crop cultivation and forest (respectively 0.4 and 0.5 ha on average). Land defined as 'animal land' is negligible, suggesting that cattle may graze freely in the fields, in common grazing areas or in the forests. Households with more than ten cows own on average much more land than other cattle farmers, holding on average four ha of land, and a large proportion is a forest (about 75 percent, three ha on average).

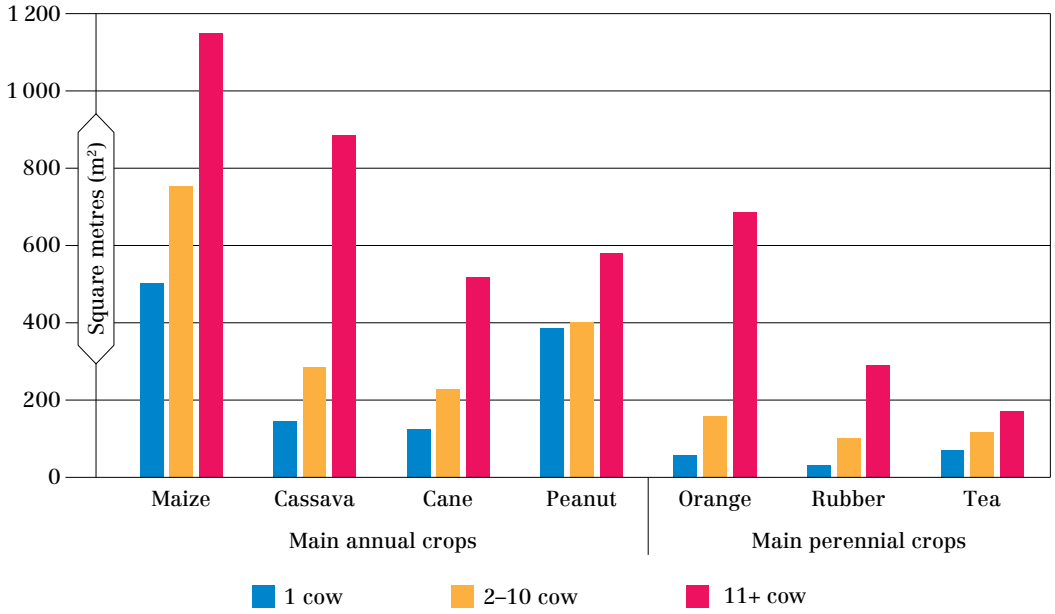
The ownership of a larger number of cows, which appears to go hand in hand with greater land and forest endowments, may also point to a higher risk with respect to deforestation. This may be reinforced by the finding of the previous section that households with more land may be more likely to fall into poverty, and, therefore more inclined to clear trees in order to gain additional economic returns. Indeed, larger forest land endowments may induce households to clear trees, as some deforestation might not affect the overall

forest ownership on the one hand, and some economic returns may be derived on the other. Hence, the medium-large scale cow farmers (with more than ten cows) may constitute a higher-risk category for deforestation.

The small-scale cow farmers (with 2–10 cows) could also play a role in deforestation, even though their forest ownership is limited: owning less land, they might be more constrained and the need of land to cultivate crops or grass for cattle, or for cattle grazing (or for stall building), might push them to clear trees. This could occur within their land, but also in the nearby area if their need is very strict. Even though the impact of the single small farmer might not be huge, the size of the small-scale cow farmer's category is such that the aggregate impact might be substantial. Scarce land tenure security is also a factor that might induce farmers to have a short-term view of their land and not to "care" about deforestation in their plots.

Eventually, the existence of the potential links between cow rearing households and deforestation may be reinforced by the fact that households with 2–10 cows and 10+ cows are mostly located in communes with higher average levels of deforestation in 2016 as well as in quintiles of higher average tree loss (RAFC, 2016).

FIGURE A18 Main crops (besides rice) cultivated by cow rearing households in Nghe An and Ha Tinh



Source: GSO. 2016. *Rural, Agriculture and Fishery Census.* Hanoi.

Annex 6. Empirical analysis: detailed description of data, methodology and results

Description of data

The analysis develops on a wide set of information obtained from the spatial merge between two national agricultural censuses for the years 2011 and 2016 and a set of refined and updated geo-localized indicators of deforestation, infrastructural development and economic activity.

The main dependent variables are the area of tree loss in 2016 and the cumulative area of tree loss between 2011 and 2016. These indicators derive from the Global Forest Change database developed by the Department of Geography of the University of Maryland (Hansen *et al.*, 2013). This database delivers raster images on global forest change with a resolution of 30 metres per pixel at the equator. These images are the result of the yearly re-elaboration of the Landsat images between 2000 and 2018 and allow for the calculation of each commune's areas of tree loss by year, from which we derive the main dependent variables. From this source, the control variable on the level of forest coverage in the year 2000 is also derived, which is added among the set of controls under the assumption that areas with higher level of forests will observe higher levels of tree loss.

Information for cow rearing derives from two waves of the Rural, Agricultural, and Fishery Census (RAFC), which is a survey conducted every five years by the General Statistics Office of Viet Nam (GSO). The survey provides a complete picture of the agricultural production in Viet Nam by gathering a large set of socioeconomic and agricultural information for all of the rural households, involving about 14 million household units. The gathered data includes, among other, the demographic structure of the households, the level of education of their components, their labour allocation, land use, agricultural production, and the level of livestock and tools endowment. The household level information is integrated with a large and detailed set of supplementary records on the specificities of the farms operating in the same territory and on the basic situation of the communes selected by the sample design. Due to the size of the sample, it would be difficult if not impossible to identify and follow each household across the time, and therefore implementers have designed RAFC to be a repeated cross-sectional survey. While this condition may represent a limitation for household level analyses with few observations for each geographical unit, the present analysis may take advantage of the representativeness of the survey to construct indicators both on the level and intertemporal change of cow rearing activities for all the communes for Viet Nam and for the selected provinces (Nghe An and Ha Tinh). Using RAFC 2011 and RAFC 2016, commune-level indicators on cows per capita are constructed, using the size of the population in the commune as the denominator. Data from the census are also used to build a set of controls at the commune level. Based on what is found in the extant literature, the specification includes controls on the average level of age and education of commune's members (Ehrdart-Martinez, 1988), the level of population and the share of individuals belonging to the two prevalent ethnic groups (Cropper, Griffiths and Mani, 1999), the share of individuals self-employed, employed in industry and in agriculture, the cropland area per capita and the paddy-field area per capita (Bhattharai, Conway and Yousef, 2009). In addition, using a principal factor analysis on a range of indicators regarding the ownership of a set of mechanical tools, the resulting principal component is employed to generate a mechanization index (Byerlee, Stevenson and Villoria, 2014).[7] Finally, from

[7] The set of tools include more than 28 items, among which sewing machines, harvesting machines, corn separators, peeling and shelling machines, and electric generators are included. For the full list of tools see the Annex.

the census, an indicator on the natural forest land managed by household farmers was constructed, which is employed as an additional dependent variable in the robustness tests. For the sake of the interpretation of the results, all of the continuous dependent variables are transformed into natural logs.[8]

This data is complemented with information on access to infrastructure and the level of economic activities from several sources. The specification includes a night-time light index obtained from the National Centres for Environmental Information of the National Oceanic and Atmospheric Administration (NOAA). This index spans between 0 and 63, with 63 denoting the highest level of night-time light. This indicator enters the specification as a proxy of economic activity and allows us to distinguish between highly urbanized and more remote communes (Elvidge *et al.*, 2012). Extant literature suggests that deforestation is strongly associated with the level of road development (Cropper, Griffiths and Mani, 1999), thus the specification includes a variable measuring the average distance from highway, primary and secondary roads, obtained using the Global Roads Inventory Project (GRIP) dataset (Meijer *et al.*, 2018). Finally, to account for the influence of market accessibility on deforestation, a control on the distance from the cities provided by Pulsipher's World Regional Geography (7th Edition) Data Group is added.[9]

Table A6 presents the summary statistics for the dependent and explanatory variables in the two province sub-sample and shows that, on average, the communes of Nghe An and Ha Tinh provinces experienced a tree loss of about 81 ha in 2016, representing 45 percent of the total loss during the period 2011–2016, equal to around 178 ha.[10] The communes have, on average, a cow population of 824 units, with only 5 percent of the communes (39 communes) holding a cow population lower than 100 units. The summaries of the nightlight index, distance from the cities, and distance from roads, suggest that a large portion of the provinces are composed by rural communes which still observe a low level of infrastructural development and human activity, with the exception of the areas surrounding the two largest cities (Vinh and Ha Tinh). This variable takes an average value of five, but more than 50 percent of the communes report a nightlight index lower than 4.5 and only 5 percent of the sample has a nightlight index higher than 15.75. Since household data derive from a rural agricultural census, it is understandable that a large part of these households is composed of individuals who are self-employed, and employed in agriculture and/or forestry. Finally, the vast majority of the population in the two provinces belongs to the Kinh ethnic group, with only 9 percent from the Tay group and a minority of other groups, among which include the Thai and Muong groups.

The level of cow rearing activities appears to have increased in areas which experienced higher levels of cumulative tree loss during the period 2011–2016 (see Table A7). The average cow units in the quartile that experienced the higher level of tree loss is about 2.2 times higher than the one observed in the quartile with the lowest level of tree loss. The level of tree loss does not appear to be driven by increased population pressure, since the size of population does not substantially vary with levels of deforestation. In contrast, from the summaries on cropland size and employment status, the level of self-employment in agriculture, which often corresponds to low-skilled agricultural activity, can be linked to the level of cumulative tree loss. Employment in agriculture does not vary substantially across the distribution of cumulative tree losses.

8 To avoid losing the zero–value observations in the dataset, we add 1 to the dependent variables before logging them.

9 Data retrieved from https://hub.arcgis.com/datasets/6996f03a1b364dbab4008d99380370ed_0

10 For the sake of brevity, not all of the summary statistics on Viet Nam are not reported but are available upon request.

TABLE A6 Summary statistics of the variables at commune level

Variable	N	Mean	SD	Min	Max
Dependent variables					
Cumulative tree loss 2011–2016 (ha)	728	178.16	326.02	0.00	2 530.70
Tree loss in 2016 (ha)	728	81.38	140.45	0.00	1 314.99
Explanatory variables 2016					
Cow units	728	824.93	538.84	0.00	3 886.00
Forest land area (ha)	728	2 575.99	4 573.33	61.69	43 905.05
Nightlight index	728	5.04	6.63	0.00	62.00
Distance from cities (km)	728	37.67	26.95	0.00	119.59
Distance from roads (km)	728	17.00	13.59	0.00	77.83
Average years of education	728	1.85	1.16	0.23	10.36
Average age of the population	728	51.42	4.74	25.26	62.48
Rural population size	728	2 975.82	1 471.14	70.00	8 898.00
Wealth index	728	-0.00	0.39	-0.99	2.60
Share of self-employed	728	0.84	0.09	0.37	1.00
Share of employed in the industry	728	0.15	0.12	0.00	0.63
Share of employed in agriculture	728	0.26	0.14	0.01	0.74
Share of employed in forestry	728	0.17	0.27	0.00	1.00
Cropland (ha)	728	359.73	243.65	0.05	1 965.86
Paddy field land (ha)	728	216.32	144.87	0.00	1 050.78
Share of Viet population	728	0.86	0.31	0.00	1.00
Share of Tay population	728	0.09	0.25	0.00	1.00
Share of Thai population	728	0.01	0.09	0.00	1.00
Share of Muong population	728	0.02	0.09	0.00	0.88

Notes: The table reports the summary statistics for the sample. Share of employment status do not sum to 100 as some households showed multiple individuals working in different sectors.

Source: Authors' own elaboration.

TABLE A7 Summary statistics for selected variables by cumulative tree loss quartile

	Cumulative tree loss 2011–2016			
	First quartile	Second quartile	Third quartile	Fourth quartile
Cow units	489.13	764.49	907.07	1 139.01
Rural population size	2 833.97	3 073.56	3101.12	2 894.62
Share of self-employed	0.78	0.81	0.86	0.89
Share of employed in the industry	0.21	0.19	0.14	0.07
Share of employed in agriculture	0.31	0.30	0.24	0.18
Share of employed in forestry	0.01	0.02	0.16	0.49
Cropland (ha)	252.86	304.17	437.56	444.32

Note: The table displays the average value of a set of explanatory variables by quartiles of cumulative tree loss.
Source: Authors' own elaboration.

Methodology

The methodological approach employed in the analysis can be divided into two steps. The first step answers the question of whether higher levels or rate of changes of cow rearing activities correspond to higher levels of tree loss. In the second step, the approach is extended to investigate whether cow rearing can also impact the level of deforestation beyond the commune in which they are found.

Correlation between cow production and deforestation

Using the set of variables illustrated in the data section, the first stage of the analysis focuses on studying the cross-sectional and dynamic correlation between deforestation and cow rearing. The cross-sectional deforestation is modelled using a simple log-log OLS specification as follows:

$$treeloss_i = \delta cow_i + \beta X_i + \varepsilon_i \tag{1}$$

Where the dependent variable represents the natural log of the tree loss area in 2016. The main explanatory variable is the natural log of cow units, with δ denoting the associated coefficient. The set of controls X_i includes the variables illustrated in Table A6 associated with a vector of coefficients β, while ε_i represents the independent and identical distributed error terms clustered at commune level.[11]

To study the dynamic between deforestation and changes in cow rearing activities, the specification (1) is slightly modified as follows:

$$cumulative_treeloss_{i\,(2011–2016)} = \delta \Delta cow_i + \beta X_i + \varepsilon_i \tag{2}$$

Where the dependent variable is the natural log of the cumulative tree loss area between 2011 and 2016, and the main explanatory variable is the difference in the natural log of the cow rearing activities between 2011 and 2016, which can be interpreted as the growth rate of these activities between the 2011 and 2016 agricultural census. The set of controls remains the same as those of Equation (1) and the errors remain clustered at commune level.

[11] To be consistent with the log–log specification, all the continuous controls are taken as natural log.

Spatial correlation between cow rearing and deforestation

The analysis is extended using a Spatial Durbin Model (SDM) for the two provinces under consideration, which is an approach widely adopted to test the existence of potential spatial correlation with deforestation while accounting for the level of spatial autocorrelation (Amin *et al.*, 2019; Richards, Walker and Arima, 2014; Santos and Almeida, 2018). This pproach has been theoretically justified by the literature on deforestation, which models the phenomenon as an interactive process subject to different factors, among which the resource availability and the opportunity cost of the agents involved in deforestation (Santos and Almeida, 2018). The advantage of this model relies on its capability of disaggregating the observed effect of cows rearing on deforestation, into a direct and indirect effect, with the first one being the effect of an increase in your explanatory variable in a commune on the dependent variable in the same commune, and the second one being the spatial spill over on the dependent deriving from an increase in the explanatories in the nearby communes. The SDM takes the following form:

$$cumulative_treeloss_{i\,(2011\text{–}2016)} = \rho W cumulative_treeloss_{j\,(2011\text{–}2016)} + \delta cow_i + \tau W cow_j + \beta X_i + \theta W X_j + \varepsilon_i \quad (3)$$

$$\text{with } W = [W_{11}\ W_{12} \ldots W_{1n}\ W_{21}\ \ W_{22}\ \ldots\ W_{2n} \vdots \vdots \ddots \vdots\ W_{n1}\ W_{n2} \ldots W_{nn}\ ]$$

Where the term $cumulative_treeloss_{i(2011\text{–}2016)}$ denotes the cumulative tree loss (2011–2016) for the commune i and depends on the level of tree loss in the spatially contiguous commune with $j \neq i$, and where ρ represents the linked coefficient and W the spatial weighting matrix for communes i=[1…n], allowing potential spatial correlations to be accounted for. The spatial weighting matrix W takes the form of a binary contiguity matrix, where component W_{ij} assumes a value equal to one if commune i and commune j are spatially contiguous. The main dependent variables are the level/change in number of cows reared in the observed commune with the coefficient denoted by δ, and the level/change in cow numbers in the spatially contiguous commune, with τ indicating the associated coefficients. The specification also includes the term X_i, representing the set of controls for commune i with β the associated coefficients, and the component X_j denoting the set of controls in nearby communes, with θ the vector of coefficients, and ε_i being the normal distributed error term.

Detailed results

TABLE A8 Beef production activities are both associated with increase in tree loss measured by satellites, 2016

Variables	(1) Tree loss area in 2016 (ln)
Cows per capita (ln)	0.218 ***
	(0.076)
Area of forest land in 2010 (ln)	1.422**
	(0.666)
Nightlight (ln)	-1.017***
	(0.333)
Distance from cities (ln)	1.387***
	(0.308)

TABLE A8 (cont.) Beef production activities are both associated with increase in tree loss measured by satellites, 2016

Variables	(1) Tree loss area in 2016 (ln)
Distance from roads (ln)	0.898***
	(0.307)
Average years of education in the commune (ln)	0.629
	(0.650)
Average age of the commune members (ln)	222.847
	(138.192)
Rural population of commune (ln)	0.078
	(0.454)
Wealth/mechanization index	0.403
	(0.499)
Share of self-employed in household	7.857***
	(2.370)
Household works in industry (1=yes)	0.309
	(2.214)
Household works in agriculture (1=yes)	-1.913
	(1.574)
Household works in forestry (1=yes)	4.397***
	(1.566)
Cropland area per capita (ln)	0.449
	(0.331)
Paddy-field area per capita (ln)	-0.093
	(0.098)
Constant	-1 733.000*
	(1 046.764)
Ethnic controls	Yes
Observations	724
R-squared	0.584

Notes: The table reports the estimated coefficient from an OLS model with the natural log of the tree losses in 2016 as the dependent variable. The unit of observation is the commune, and the main explanatory variable is the natural log of the cow units. Level of significance are *** p<0.01, ** p<0.05, * p<0.10. Errors are clustered at the commune level.

Source: Authors' own elaboration.

TABLE A9 A percentage increase in beef production activities is associated with increase in cumulated tree loss, 2011–2016

Variables	(1) Log of cumulative tree loss (11–16)
Log difference in total number of cows per capita (2016–2011)	1.178*
	(0.611)
Area of forest land in 2000 (ln)	0.649**
	(0.301)
Nightlight (ln)	-0.716***
	(0.118)
Distance from cities (ln)	0.278***
	(0.100)
Distance from roads (ln)	0.394***
	(0.091)
Average years of education in the commune (ln)	0.318
	(0.199)
Average age of the commune members (ln)	154.181***
	(50.171)
Rural population of commune (ln)	-0.013
	(0.179)
Wealth/mechanization index	0.054
	(0.171)
Share of self-employed in HH	2.801***
	(0.755)
HH works in industry (1=yes)	0.671
	(0.744)
HH works in agriculture (1=yes)	-1.136**
	(0.537)
HH works in forestry (1=yes)	3.263***
	(0.683)
Cropland area per capita (ln)	0.124
	(0.126)
Paddy-field area per capita (ln)	-0.020
	(0.039)
Constant	-1 186.275***
	(379.549)

TABLE A9 (cont.) A percentage increase in beef production activities is associated with increase in cumulated tree loss, 2011–2016

Variables	(1) Log of cumulative tree loss (11–16)
Ethnic controls	Yes
Observations	724
R-squared	0.736

Notes: The table reports the estimated coefficient from an OLS model with the natural log of the cumulative tree losses in the period 2011–2016 as the dependent variable. The unit of observation is the commune, and the main explanatory variable is the log-difference of the cow units for the period 2011–2016. Level of significance are *** p<0.01, ** p<0.05, * p<0.10. Errors are clustered at the commune level.

Source: Authors' own elaboration.

Annex 7. Insights from the fieldwork

The fieldwork was conducted in the period 5–20 October 2020 in seven districts in Nghe An (Vinh city, Thanh Chuong, Tan Ky, Yen Thanh, Thai Hoa town, Nghia Dan, Quy Hop) and three districts in Ha Tinh provinces (Hong Linh town, Huong Son, Vu Quang). Several meetings and interviews were also conducted in Hanoi before and after the fieldwork with relevant stakeholders.

The main objectives of the fieldwork were to get insights on local drivers of deforestation, get insights on the dairy and beef value chain in the provinces, and capture whether there could be some evident/visible linkages between forest loss and the two sectors. To meet these objectives, the following activities have been conducted: 1) interviews with various stakeholders on the beef and dairy value chains, as well as impacts on deforestation (if any); 2) small-sampled surveys with cow smallholders; 3) site visits and observations. The full list of meetings and persons consulted is listed in Table A10.

TABLE A10 Stakeholders interviewed during FAO field visit, October 2020

Stakeholders interviewed
Hanoi
Department of Forest Protection
Department of Investigation on Forest Violations
Forest Protection Research Centre, Vietnamese Academy of Forest Science
Viet Nam Ruminant Husbandry Association
Animal Science and Technology Institute of the Animal Husbandry Association of Viet Nam
Viet Nam Dairy Association
Nghe An province
Nghe An Department of Livestock and Animal Health
Nghe An Department of Crop Production and Plant Protection
Nghe An Province Department of Forest Protection
Golden Star Feed Company, Vinh
Petro Food, Vinh
Huong Yen slaughterhouse, Vinh
Thanh Chuong Forest Protection Department and Agriculture Department
Tan Ky Forest Protection Department
Nghia Dong Commune Cow Cooperative, Tan Ky
Kieu Phuong Farm, Nghia Dong commune, Tan Ky
Yen Thanh Forest Protection Department and Agriculture Department
Medium-sized farm, Thinh Thanh commune, Yen Thanh
TH Truemilk dairy company, Nghia Dan
Vinamilk dairy company, Thai Hoa
Chau Thai Commune People's Committee, Quy Hop
Chau Thai Youth Cow-breeding Club, Quy Hop
Quy Hop Forest Protection Department and Agriculture Department

TABLE A10 (cont.) Stakeholders interviewed during FAO field visit, October 2020

Stakeholders interviewed
Ha Tinh province
Vinamilk dairy farm, Sơn Lễ commune, Huong Son
Khanh Giang beef cow farm, Hong Linh town
Duc Huong Commune People's Committee
Vu Quang Forest Protection Department and Agriculture Department
Mitraco Company, Ha Tinh
Interviews with cow smallholders
Thanh Thuy commune, Thanh Chuong (2 farmers)
Thanh Nho commune, Thanh Chuong (5 farmers)
Nghia Dong commune, Tan Ky (5 farmers)
Minh Thanh commune, Yen Thanh (5 farmers)
Thinh Thanh commune, Yen Thanh (5 farmers)
Thai Hoa town (3 dairy farmers)
Nghia An commune, Thai Hoa (5 farmers)
Chau Thai commune, Quy Hop (5 beef farmers)
Duc Huong commune, Vu Quang (5 farmers)
Site visits
Dau Moi wholesale market, Vinh
Ú live cattle market, Do Luong
Production forest in Thanh Thuy commune, Thanh Chuong
Vinamilk dairy company,Thai Hoa and Huong Son
TH Truemilk dairy company, Nghia Dan

Source: Authors' own elaboration.

The key takeaways from fieldwork's interviews are reported below:

- Interviews with relevant stakeholders (including the International Union for Conservation of Nature (IUCN), Nghe An Department of Crop Cultivation and Plant Protection, Forest Protection Departments) provided evidence that at the province level, **planted forests are mostly made up of monoculture acacia stands**, backed by the quick economic returns. Moreover, they pointed to the fact that often, fire is used to clear land to then plant acacia.
- Interviews also showed that **households are in some cases using forest land for production activities**, mainly due to the lack of means to profit from forest land, and no proper compensation mechanisms for preservation of natural forests are in place; the limited agricultural land, the unclear border of forest land managed by different entities and the scarce regulatory activities due to lack of budget.
- There is evidence of the expansion of feed crop cultivations, mainly maize and grass.
- Purchasing feed crops from farmers in the province is key. There is the competition to secure feed. Sometimes the lack of feed is an obstacle for commercial farms to expand, even though they would have the capacity to do so.

- The lack of connection with the end market hinders business sustainability. The lack of cooperatives and of support mechanisms prevents commercial farms from expanding.
- The lack of adequate cow rearing techniques brings losses and prevents expansion.

Insights from the field: evidence of deforestation

Natural forest conversion to planted forests and deforestation: summary of field interviews

In Ha Tinh province, the International Union for Conservation of Nature (IUCN) estimates that 77 percent of planted forests are monoculture acacia stands, which are younger and with short duration (IUCN, 2018). Similarly, in Nghe An, according to the Deputy Head of Nghe An Department of Crop Cultivation and Plant Protection, 146 000 out of 180 000 ha of planted forest consists of acacia due to its quick economic returns just after a short period of 4–5 years. Officials from both the national and local Forest Protection Departments consulted during the field visit have confirmed that deforestation to convert forest land for acacia is currently one of the most burning issues.

In further discussions with the officials, it appears that households living near forests have been found to use forest land for commercial activities, and the unclear borders of the forest land managed by different entities is one of the reasons behind this issue. Indeed, donor project teams that were interviewed during the field work pointed out that due to poor land planning and the lack of compliance with the Forestry Law of 2017, forest land is at times overlapped with land under other usages. Individual households are still found to lend or sell forest land to one another illegally at times when income opportunities are scarce. This is because households living near forests often rely on forest extraction activities for their livelihoods and as agricultural land is limited, the pressure to acquire new production forest land is high.

Officials from the Tan Ky Forest Protection Unit emphasized that many households managing natural forests are discontent with the lack of means to income from the forests under their management, and this oftentimes leads to land conflicts. Households responsible for preserving natural forests under their management are not properly compensated for their efforts despite government intentions through Decree 75. Therefore, according to the Central and local Forest Protection Departments (Yen Thanh, Quy Hop, etc.) and the Viet Nam Forest Protection Research Center, households in Nghe An and Ha Tinh can frequently be found clearing natural forest areas for conversion to planted forests.

Some households can also be found building housing structures and barns for livestock inside the forest, even though regulations such as Decision 38/2016/QD-TTg, only allow infrastructure construction on the forest land that does not yet have trees (or 'forest land without trees'). Furthermore, officials from the Nghe An stated during field interviews that forests are continuously being converted to land for other usages. For example, in Yen Thanh district, officials decided to grow acacia. In 2020, seven projects in Nghe An province were approved for land conversion from forests. Officials from both the provincial and district level forest protection departments have stated that illegal timber extraction has recently not been an issue, with “no cases of deforestation for timber in recent years”.

In almost all interviews with officials from the national, provincial and district level forest protection departments, the lack of budget for forest protection work and the subsequent shortage in forest protection officers has been highlighted as another challenge in carrying out regulatory activities. According to the Deputy Head of the Forest Protection Department of Nghe An, the province lacks 400 officers to fulfil the intended goal of maintaining one forest protection officer per 1 000 ha of forest land.

Human induced forest fires to acquire land for acacia trees

According to the Central Forest Protection Department interviewed during FAO's field visit, in 2019, 30 deforestation cases were reported in Nghe An, and 19 in Ha Tinh, and most of them were caused by households to acquire more lanine months of 2020 were done by households to acquire land for acacia. Several stakeholders raised the concern of forest fires induced by households in natural or protected forest areas, so that once the trees have been burnt down, households can try to seek permission to reforest these areas with acacia.

At the time of FAO's field visit, there have been 21 forest fires in Nghe An province in 2020, with an affected area of 122 ha, of which 70 ha are pine forest and 45 ha cannot be restored so it will need to be replanted with new trees (Nghe An Forest Protection Department and Department of Crop Cultivation and Plant Protection). Most of the affected areas are in the protected forests.

In Ha Tinh, in 2019 there were 20 forest fires, damaging 171 ha of forest land and showing an increase of ten more cases compared to 2018; reasons were attributed to a long period of drought and people's carelessness in the forest (Ha Tinh Statistics Office, 2019). One official pointed out the Nghi Xuan forest fire in Ha Tinh also happened in a pine forest and the area was later converted to acacia.

Insights from the field: dairy and beef value chain actors

Small family farmers and cow rearing in nearby forests

During the visit to the production forest in Thanh Thuy commune (Thanh Chuong district, Nghe An province), some households living in the forest area were found to have built cow barns and let their cows graze freely in the forest. The households are forest owners with 50-year land use rights. Most households have their houses built in the forest and settle their lives there, as well as barns for the livestock, and sometimes even wood processing factories. It has been observed that certain areas of the forest land managed by the households are also cultivated with tea.

Kieu Phuong company, Nghe An

Kieu Phuong is one of the three companies that manage forest land in Nghia Dung commune, Tan Ky district, Nghe An. The company manages 580 ha of production forest, of which 18 ha in the production forest has been converted for a cow project (barns, structures) and five ha is dedicated to grass cultivation. The company first imported 300 beef cows from Australia in 2012, and at the highest point, they had up to 1 000 cows in these structures in the forest. However, due to the lack of knowledge on cow rearing techniques and procedures, they suffered losses and sold all the cows in 2019 and are now using the barns to breed and fatten buffalos. At the time of visit, they currently have around 300 buffalos. The company is currently seeking approval to convert some production forest land area for a pig breeding project.

Small family farm contracting with Vinamilk

Ms Nhung's household bought five dairy cows of HF breed from Vinamilk in 2015. At the time of the interview, the herd counted 13 cows. She signs a contract yearly with the dairy plant in Cua Lo. Each month she sells 4 200 litres of milk back to the company, on average. The cows are milked twice a day; milk is kept in the tanks provided by Vinamilk, and then transported to the collection point twice a day, at 6 am and 6 pm. The family farm cultivates maize and grass on one ha of land, which was previously used to grow coffee. Dairy cow rearing has provided more economic income to her household than crop cultivation. According to Ms Nhung, the main risk involved in dairy cow rearing is the lack of knowledge on proper cow rearing techniques and procedures, which may lead to serious cow illnesses and to detrimental consequences for the business.

Medium-scale farm - Khanh Giang company, Ha Tinh

Khanh Giang company signed a contract with Vinamilk dairy plant in Cua Lo in 2015, and it directly imported 200 HF cows from Australia. Out of the 27.8 ha of land the company owns, 20 ha is dedicated for grass cultivation. The owner assessed that nowadays, it is difficult in Ha Tinh to acquire a large area of land for livestock production, as most large land areas have been used for pig breeding.

The company views that Vinamilk sets milk standards too high, possibly higher than international standards, and when the milk produced does not meet Vinamilk's standards, the price will be deducted greatly. Due to the losses in 2020 and unstable milk price with Vinamilk, the company has sold all the dairy cows, and plans to open their own dairy company with a new imported cow herd and pasteurization system.

Medium-scale commercial farm - Mitraco company, Ha Tinh: a unique example of closed-loop supply chain

Mitraco is one of the biggest commercial farms in Ha Tinh. The company engages in several livestock productions, including, one cow farm in Cam Xuyen district, with 600 Braham breed cows imported from Australia, and a second farm in Ky Anh district, with 600–1 000 cows. Although the company has 65 ha dedicated to grass cultivation in these two districts, they still need to buy extra fresh fodders annually from farmers in the province to feed the large cow herd. This company is the only one in the two provinces with a closed-loop supply chain, from cultivating their own feed crops, breeding and fattening cows, to operating a meat processing chain and selling to retailers. The slaughtering facility also has a cold storage for frozen meat and beef.

Mr Nguyen Cong Tinh's medium-sized farm, Nghe An: The story of a successful business expansion, but the lack of connections with end markets hinders success' sustainability

Mr Tinh's household in Thinh Thanh commune, Yen Thanh district, is one of the few households that have successfully expanded the business from cow-breeding to fattening and also slaughtering. The household raises 40 yellow cows at a time in barns (part-grazing, part-feeding), and fattens cows for around six months (from 18-month-old to 24-month-old) before selling as live cattle or slaughtering at a nearby dedicated slaughter area established by the commune. Last year, the household slaughtered 300 cows. They mainly sell fresh beef to local consumers and local markets, and sometimes to orders from restaurants in Hanoi. The farm is looking to expand as they have the capacity to breed and fatten more cows, but the main challenge is they do not have access to the consumption market or non-local consumers. The lack of cooperatives or support mechanisms to connect producers like this farm to consumers is one of the hurdles that prevent successful medium-sized farms from developing into large-scale commercial farms, although there still exists a big gap between domestic production and beef consumption in Viet Nam.

Mr Linh's farm, Nghe An: the lack of feed as one of the main reasons why commercial farms cannot expand

One of the largest cow farms owned by households is Mr Linh's farm in Nghia Binh commune, Nghia Dan district (Nghe An). The farm acquires and resells about 600–800 cows a year. All the beef cows (male cows) come from TH TrueMilk dairy farms, through the intermediation of a trader. However, each time the farm purchases 100 cows, 70 cows will be resold, while the remaining 30 cows will be fattened until they weigh one ton (or reach two years old). The rationale is to recover investment cost and because the lack of green feed makes it impossible to fatten all 100 cows at one time. The farm raises the calves until they are seven months old (weighing 200–300 kg) and then sells them to households as cow breeds. Mr Linh currently has three ha to cultivate Mombasa grass, elephant grass and maize crops, while the total area of his cow structures and facilities is one ha.

Huong Yen slaughterhouse in Vinh city, Nghe An

Within the past ten years, the number of slaughterhouses in Vinh city has reduced from five to three, although beef consumption in the city has substantially increased. Mr Huong's slaughterhouse (also known as Huong Yen slaughterhouse) is one of the oldest, with 25 years of operating history. The slaughterhouse currently purchases Australian live cows from companies within and outside of the province, as Australian beef is preferred by customers, especially since the price of Australian beef is roughly the same as local beef. The facility slaughters 60–70 cows per day on average, according to orders received, and all fresh beef is sold out daily to retailers in local markets, restaurants, etc.

Mr Huong has been looking to expand his business for years, by asking for approval from the authorities to convert his 2 500 m2 of agricultural land (now unused) for a new cow fattening farm and a second slaughterhouse, but without much success due to the lack of lands use rights and the challenge in converting paddy field to other usage.

At the same time, the Provincial Department of Livestock Production shared the difficulty in attracting the investment for a large-scale, advanced slaughterhouse (as the one in Ninh Binh province).

Reported facts witnessing the expansion of maize and grass area within Nghe An and Ha Tinh

Agriculture Department of Yen Thanh district, Nghe An province

The Agriculture Department of Yen Thanh district confirmed that maize area (around 200 ha) has increased in recent years, and that several communes in the district have signed maize contract with TH and Vinamilk: for instance, Bao Thanh commune – 50 ha; Quang Thanh commune – 25 ha, Lien Thanh – 30 ha, Cong Thanh – 30 ha. The average price is about 900 000 VND per ton of maize.

Agriculture Department of Quy Hop District, Nghe An province

In Quy Hop district, the Agriculture Report of December 2019 specified that maize area for the spring season has increased by 350 ha compared to the same period last year (from 705 ha to 1 055 ha) while there is only a slight increase in other crops like peanut and vegetables, and a decrease in rice, potato and perennial crops. This also corresponds to an increase of 763 cows from 20 030 to 20 595 in the province.

Chau Thai Commune People's Committee, Quy Hop District, Nghe An province

In Chau Thai commune, currently, 15 ha of agricultural land is for grass cultivation, but the Commune People's Committee just developed a work plan to grow grass as feeds for cows last month, which will expand about 35–40 ha of land for grass cultivation from now until 2025.

This technical study suggests a set of key policy reforms to transform the general agricultural sector as well as the specific dairy and beef sectors to ensure agricultural growth does not come at the expense of forest loss.

The study unpacks the potential, current and future, linkages between beef and dairy development and deforestation, to identify entry points for government interventions. It uses Nghe An and Ha Tinh provinces in Viet Nam as case study, where the beef and dairy production increases are important and potential impact on the primary forests is of particular concern. It shows how beef and dairy expansion creates demand for additional land, which combined with existing land constraints, increases risk of further deforestation.

The study also proposes possible entry points for developing deforestation-free value chains, which are key for decision-makers to enact new policies to overcome the dual challenge of agriculture growth without forest loss, which is likely to intensify if no action is taken.

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