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The Fragmenting Countryside and the Challenge of Retaining Agricultural Land: The Vermont Case

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ABSTRACT

Many rural areas in the United States and Europe have been changing from agricultural landscapes to a mix of farm and nonagricultural uses. The fragmentation of agricultural land reflects the higher value of nonagricultural uses but may pose a threat to agricultural operations. Vermont, a rural state, has tried to slow the loss and fragmentation of farmland. Agricultural census and land parcel data are analyzed to identify what are the supply and demand factors of fragmentation, what are the pros and cons of fragmentation, and have Vermont's efforts to regulate development and sustain farming slowed the conversion and fragmentation of farmland? The amount of Vermont farmland has declined sharply since 1959 and a considerable amount of rural land has been fragmented into lots that have limited value for dairy production, the state's primary agricultural industry. Vermont's farmland preservation programs appear to have had some success in slowing farmland loss after 2002. However, the economics of farming will continue to challenge the viability of agricultural operations.

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Introduction

Over the past several decades, many rural areas in the US and Europe have experienced the fragmentation of the landscape into smaller ownerships, and more diverse land uses and social make-up (European Environment Agency and Europe 2011; Frank and Hibbard 2019; Meeus 1993; Murdoch et al. 2003; Primdahl and Swaffield 2010; Van der Sluis et al. 2019). The concept of rural land fragmentation encompasses not only the subdivision of land into smaller parcels, but also the greater number of new parcels, the size and shape of the new parcels, and the scattering of these smaller parcels across the landscape (King and Burton 1982).

Drivers of land supply that make rural land available for sale in smaller parcels, along with the drivers of demand for these parcels, will vary across rural landscapes and over time (Ntihinurwa and de Vries 2020). The main driver of rural parcel supply involves changes in farm technology and economies of scale that affect the profitability of

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farming; and the primary driver of parcel demand comes from urbanization or counter-urbanization as city and suburban dwellers acquire rural properties for residences, businesses, and second homes (Gallent and Scott 2019; Kjelland et al. 2007; Paris 2019; Primdahl and Swaffield 2010). Other supply-side reasons for rural land fragmentation include the aging of rural landowners, regulation of land subdivision which does little to hinder the creation of smaller parcels, and highway construction which increases the supply of rural land that is accessible for both local and non-local populations (Frank and Hibbard 2017; Kjelland et al. 2007; Scott, Gallent, and Gkartzios 2019, 3).

The research community, especially in the USA, generally regards the fragmentation of rural land as negative for wildlife habitats and for the working landscape of farming and forestry (Daniels and Bowers 1997; Healy and Short 1981; Kjelland et al. 2007). Land fragmentation results in the loss of wildlife habitats for feeding and breeding; and loss of habitat is the leading cause of wildlife decline (Kjelland et al. 2007). Farmland fragmentation is generally thought to pose threats to agriculture through raising production costs, promoting the conversion of farmland to non-farm uses, increasing land prices (parcel size varies inversely with price per hectare), and undermining local agricultural industries (Daniels and Bowers 1997; Hiironen and Riekkinen 2016; Postek, Leń, and Stręk 2019). Also, scattered development patterns are contrary to the concept of Smart Growth which advocates compact development and the protection of agricultural land and open space (Smart Growth America 2021).

Farmland fragmentation, however, may not always be negative, depending on the location, the type of agriculture, the quality of the farmland, and the minimum economic farm size. This is particularly so in developing countries where farmland holdings are often a few hectares, as explained in case studies of Albania (Ciaian et al. 2018) and Ethiopia (Knippenberg, Jolliffe, and Hoddinott 2018). Very small parcels have limited potential for mechanization and increased productivity (Hung, MacAulay, and Marsh 2007). In more remote rural areas of industrial countries with extensive crop and livestock operations, small farms may be consolidated into larger, more efficient units. Should agriculture decline in these rural settings, forests and natural areas will come to dominate the landscape (Primdahl and Swaffield 2010). The fragmenting of large, mechanized farms in more remote rural areas is often negative (Ntihinyurwa and de Vries 2020). In peri-urban or metropolitan regions near cities in industrial countries, agriculture tends to feature small intensive farming operations, such as vegetable and horticultural farms (Primdahl and Swaffield 2010). The fragmentation of farmland into smaller parcels may not be harmful to intensive agriculture and may provide affordable access to farmland for young and beginning farmers (Ntihinyurwa and de Vries 2020).

Public policies can attempt to influence the pace of fragmentation and the lot sizes that are created. First, policy makers must understand the supply and demand drivers of fragmentation in different settings (remote rural or peri-urban) and identify which form of fragmentation they wish to discourage or allow (such as parcels under 4 hectares or parcels of 4–10 hectares) (Ntihinyurwa and de Vries 2020). Then they can devise policies that address when to discourage or stimulate fragmentation, where, and why. Yet, it is important to note that policy options may not be transferable across countries or even across regions within a country for legal, political, or cultural reasons (Daniels and Keene 2018).

Although there have been many studies of farmland fragmentation in Europe and developing countries, few in-depth or longitudinal studies of rural land fragmentation have used data from the USA (Kjelland et al. 2007; Ntihinyurwa and de Vries 2020). This study fills the gap in the literature by analyzing agricultural census data and land parcel data to understand the fragmentation of rural land and farmland over time in Vermont, one of the most rural states in the USA. The study uses the Vermont case in seeking to (1) identify what are the drivers of rural land fragmentation and why; and (2) how effective have been policies and programs aimed at controlling the fragmentation of farmland over time: regulatory limits on farmland subdivision; preferential farmland property taxes; and the “preservation” of farmland through payments to farmers in return for a legally binding agreement not to convert their farmland to non-farm uses (Daniels and Keene 2018).

US Government Structure and the Land Fragmentation Policy Framework

Local and state governments in the USA have employed a variety of land use controls and financial incentives to discourage the fragmentation of farmland. Counties in leading agricultural states, such as California, Iowa, and Minnesota, use agricultural zoning with a minimum lot size requirement of 10 or more hectares for the construction of a house to discourage the subdivision of farmland into house lots or parcels with little viability for extensive agricultural production (Coughlin 1991; Daniels and Keene 2018). Oregon, for example, requires all of its cities and counties to adopt and implement comprehensive plans incorporating 19 state-level goals; chief among these goals are: (1) the adoption of urban growth boundaries to limit the extension of sewer and water lines that would otherwise enable the development of urban edge farmland; and (2) agricultural and forest zoning with large minimum lot sizes of 16 or more hectares to limit fragmentation (Oregon Department of Land Conservation and Development n.d.). Every state offers preferential property tax assessment for agricultural land to avoid situations where a heavy tax burden would force the sale of farmland, but the effects on the retention of farmland have been modest (Anderson and England 2015).

Farmland preservation through the purchase or donation of development rights did not emerge in the US until the mid-1970s. Landowners may voluntarily sell the right to develop the land to a government agency or a qualified private non-profit land trust. The restrictions on the use of the land are spelled out in a legally binding deed of a conservation easement which is recorded in the county land records and runs with the land; this means that if the land is sold or passed on to heirs, the restrictions in the deed of easement still apply. Nearly all sales of development rights are in perpetuity (Daniels and Keene 2018). Thus, it is common to say that farmland, from which the development rights have been sold, is “preserved” for agricultural uses. Farmland preservation has two main purposes: (1) to curb the loss of farmland to non-farm development; and (2) to provide funds for farmers to improve their operations (Daniels and Keene 2018). Twenty-nine states and more than 150 local governments have created purchase of development rights programs; together with the efforts of private, nonprofit land trusts, nearly three million hectares of agricultural land have been preserved nationwide (Daniels and Keene 2018). Finally, the federal government provides farm

subsidies and funding for the purchase of development rights to help retain land for farming (Daniels and Keene 2018).

For this study, it is important to recognize the differences between the structure of agriculture in the US and in Europe. The European Union has 10.6 million farms averaging 16 hectares, whereas the US has 2 million farms with an average of 194 hectares, and farms in dairy-dominated Vermont average 76 hectares (Schnepf 2021; USDA 2019). The much larger average farm size in the US and Vermont means that the farm operation must generate more revenue to maintain viability than an average EU farm. Moreover, the EU per hectare farm subsidies are nearly twice those in the US and thus support the viability of smaller farms and a broader range of farm and food products, including fruits and vegetables, compared to subsidies for extensively-produced commodities of dairy, corn, soybeans, wheat, and cotton in the US (Schnepf 2021). Very large US farms with annual sales of more than \$500,000 a year make up 141,000 farms or just 7% of all farms, but they dominate agricultural production, accounting for more than 81% of total farm output (USDA 2019). On the other end of the spectrum, 1.3 million farms produce <\$10,000 a year in gross sales. In short, US farms feature extensive agricultural production in large units; European farms are much smaller on average and more intensively farmed. Thus, farmland fragmentation may not be perceived as much of a problem in the EU compared to the US (Primdahl and Swaffield 2010; Daniels and Keene 2018; Daniels and Bowers 1997).

Government actions to influence rural land fragmentation differ widely across countries (Ntuhinyurwa and de Vries 2020). One approach to land fragmentation relies on market forces to determine where land fragmentation and development happen. This neoliberal policy suggests that buyers and sellers of land should be allowed to decide on the highest and best use of rural land. In short, the market is efficient and government regulations should not intervene in the land market (Primdahl and Swaffield 2010). Another approach may focus on keeping farmers on the land through a combination of commodity subsidies, preferential land taxation, and restrictions on the land subdivision. This policy reflects concerns about food supply, food security, the local farm economy, and a sense that the land market fails to allocate land resources in socially efficient ways (Daniels and Keene 2018). Because policy makers assume that market failure exists, this rationale provides a necessary condition, but not a sufficient condition for government intervention in the rural land market. That is, there is no guarantee that a government policy or program will produce a better outcome than the unrestricted land market. A third method may embody a rural development strategy to encourage non-farm development to provide employment and increase local incomes, or to promote agricultural economic development, or both (Frank and Hibbard 2019).

We contend that the Vermont case study presents elements of each of these three approaches to rural land fragmentation policy. These are best viewed through three time periods: (1) 1959–1969 when rural land regulations and state financial incentives for farming did not exist and the land market was virtually unfettered; (2) 1970–2002, when the State of Vermont made efforts to control development and provided financial incentives for farmers to keep their land in agriculture; and (3) 2002–2017, when the purchase of development rights to farmland “preserved” more farmland than was developed, an example of a farmer-centric policy which farmers largely embraced. This can

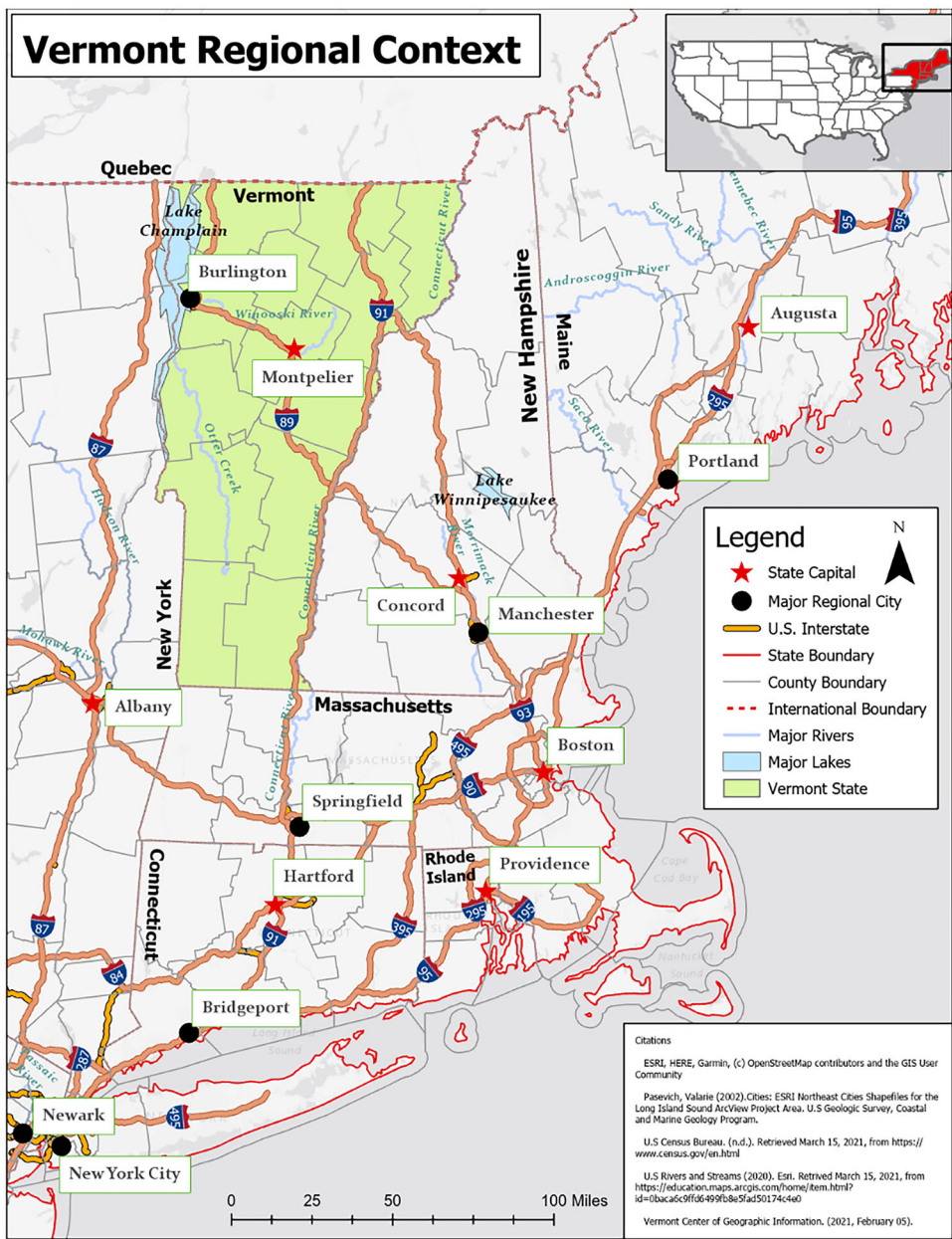


Figure 1. Vermont regional context.

also be viewed as a rural development policy to maintain the state’s agricultural industry and landscape, an important element of its tourist industry.

The Drivers of Rural Land Fragmentation in Vermont

The State of Vermont is located in the upper Northeast of the United States (see [Figure 1](#)) and only about one-third of the state’s 643,000 residents live in settlements of 2,500

or more people (U.S. Bureau of the Census 2021). Rural land in Vermont is divided among 242 towns; a town typically covers about 10,000 hectares and is a unit of local government with control over planning and zoning. Vermont has 14 counties, but unlike in most states, counties in Vermont have no control over land use regulations.

In 1960, Vermont had just 389,000 inhabitants and the state's economy relied mainly on agriculture (especially small family-owned dairy farms with an average of 98 hectares and 25 cows), manufacturing, and tourism, with land in farms comprising more than 49% of the state's 2.4 million hectares (U.S. Bureau of the Census 1960).

In the 1960s, five main drivers of land fragmentation emerged: (1) On the land supply side, a major change in dairy technology forced many small dairy farmers out of business and compelled them to sell their land. Milk handlers sought to require dairy farmers to install milk bulk tanks, which streamlined milk collection on farms. The tanks could cost as much as one year's farm revenue, which was too expensive for many small dairy farmers (Bushnell 2019); (2) The completion of the high-speed interstate highways I-89 and I-91, brought Vermont within a 3- to 6-hour drive of the Boston, Massachusetts and New York, New York metropolitan areas, enabling a counter-urbanization shift (Daniels and Lapping 1984); (3) On the demand side, the construction of major ski areas and the rising popularity of skiing drew visitors from out-of-state; (4) The demand for second homes increased (Healy and Rosenberg 1978); and (5) Many of the state's 242 towns lacked land use regulations to control the creation of new lots and development and thus did not hinder the supply of lots (Healy and Rosenberg 1978). Much of the new development relied on inadequate on-site septic systems that posed threats to water quality and public health (Healy and Rosenberg 1978).

Between 1959 and 1969, the number of farms in Vermont plummeted by 5,225 or 43.2% (U.S. Bureau of the Census 1960, 1971). Land on farms plunged by 412,000 hectares or 35%. Meanwhile, the value of farm output in 1969, adjusted for inflation, was virtually unchanged from the \$110 million in 1959 (U.S. Bureau of the Census 1960, 1971). In 1969, dairy farms averaged 42 cows, a 68% increase over 1959, reflecting a major shift in the economies of scale in dairy production in favor of larger dairies. Overall, the average farm size grew from 98 to 108 hectares, a jump of 10%. Meanwhile, the state's population grew by 55,000 people or 14% between 1960 and 1970, the largest decennial increase in more than 100 years and a rate faster than the entire US in the 1960s.

These results support the characterization of the 1959–1969 era as dominated by a neoliberal, market-based approach to land resource allocation and development. The loss of agricultural land, because of changing agricultural technology and economics, dovetailed with the rising demand for rural land for residential, recreational, and second home uses. It had become evident that the market alone was inadequate to manage rural land fragmentation (Healy and Rosenberg 1978).

Vermont's Four Public Programs to Discourage Fragmentation

Vermont has implemented four programs to influence the fragmentation of rural land in general and especially farmland. These programs include state land development controls and local agricultural zoning to address the subdivision of agricultural land,

preferential taxation of agricultural land to encourage farmers to keep their land in farming, and farmland preservation through the purchase of development rights from willing landowners who agree not to develop their land for non-farm uses. It is worth noting that Vermont cities and towns have not pursued urban growth boundaries to control land development.

State Development Controls

In 1970, the Vermont legislature passed Act 250 which established a system to regulate developments of 10 or more lots or 10 or more dwelling units according to 10 criteria ranging from impacts on water quality to impacts on government services, to the loss of agricultural land (Healy and Rosenberg 1978; Heeter 1976). Act 250 embodied a recognition that town-level planning and zoning (which did not even exist in every town) could not adequately manage land fragmentation (Healy and Rosenberg 1978; Heeter 1976). The vision underlying Act 250 was compact settlements surrounded by farms and forests, generally maintaining the traditional Vermont settlement pattern (Byers and Wilson 1983). The goal was not so much to deter development as to ensure that development met quality standards and was appropriately scaled (Daniels and Lapping 1984). To avoid the Act 250 process, which could be time-consuming and an added expense, a landowner could propose to develop up to nine lots. These lots would tend to be of limited use for Vermont's dairy-dominated farming economy, where dairy farms averaged over 100 hectares. Thus, the creation of <10 lots remained under the control of the towns. The types of fragmentation that Act 250 attempted to control were those of many residential lots, especially lots of <4 hectares, which in turn created an incentive for the subdivision of lots of more than 4 hectares.

Agricultural Zoning

Very few Vermont towns have employed agricultural zoning of 10 or more hectares. Rather, minimum lot sizes typically vary from <1 hectare to up to 2 hectares. This zoning is more often associated with rural residential development than with discouraging the subdivision of farmland into parcels too small to farm (Healy and Short 1981; Daniels and Bowers 1997).

Preferential Taxation of Farmland

The Vermont state government has offered a preferential assessment of farm and forest land, known as the Current Use Program, since 1980. The program requires a landowner to enroll a minimum of 10 hectares. Qualifying farmland must be in active use in the production of crops, livestock, tree fruit, and/or maple syrup. There is no minimum gross sales threshold. Landowners who withdraw from the program must pay a Land Use Change Tax of 10% of the full fair market value of land that is withdrawn or developed (Vermont Department of Taxes 2020). The Current Use Program offers a financial incentive to keep land for farming and in parcels of more than 10 hectares.

Farmland Preservation

In 1977, the private, nonprofit Vermont Land Trust was formed with the preservation of farmland as the main part of its mission. In 1987, the Vermont legislature created the

Vermont Housing and Conservation Board (VHCB), a state agency, to finance affordable housing and land preservation projects (Libby and Bradley 2000). From 1996 to 2014, Vermont received several millions of dollars for farmland preservation from the federal Farm and Ranch Lands Protection Program (Daniels and Keene 2018; NRCS 2021). Since 2014, the federal Agricultural Conservation Easement Program has provided matching funds to the VHCB for the purchase of development rights (VHCB 2021).

Methodology and Data

The first step to measure the degree of rural land fragmentation in Vermont is an analysis of agricultural census data on land on farms between 1969—just before Act 250—to 2017. This sheds light on whether Act 250, local zoning of agricultural land, preferential taxation of agricultural land, and land preservation efforts were able to limit the loss and fragmentation of farmland. We began with an analysis of the change in farms and farmland during the early years of Act 250. Next, we conducted a review of agricultural zoning in the 29 agricultural towns we identified. We focused on the minimum lot sizes required to build a house or nonresidential building. The larger the minimum lot size, such as 10 or more hectares, the greater the protection for agricultural land against fragmentation is likely to be. Then, we analyzed the effect of the preferential assessment of agricultural land on the loss and fragmentation of farmland in terms of hectares enrolled. Finally, we studied the impact of Vermont's farmland preservation efforts to retain land for agricultural use. Key measures are: (1) the amount of agricultural land that has been preserved compared to the loss of agricultural land; and (2) the location of the farmland that has been preserved. At a minimum, as much farmland should be preserved as is taken out of production. The farmland should be preserved where there is a concentration of agricultural activity as opposed to a handful of remaining farms.

Second, we measured the degree of rural land fragmentation as shown by both the number of total lots and agricultural lots of 4–20 hectares and the amount of land in those lots. We used data from the Census of Agriculture of 1969, 2002, and 2017 and the 2018 Vermont Parcel Program. In 2016, the Vermont legislature created the Statewide Property Parcel Mapping Program, to “develop, maintain, and make available property parcel data available to State agencies and departments, regional planning commissions, municipalities, and the public” (Vermont Act 158 of 2016).

The third step is to determine the extent of small-lot and large-lot rural land fragmentation measured by whether there are more 4- to 10-hectare parcels in number and land area than 1.2- to just under 4-hectare parcels. We used town-level data from the Vermont Parcel Program to identify the number of lots and the amount of land by lot size categories. The land parcel data were also used to make a comparison of lots among five types of towns: (a) agricultural; (b) residential; (c) rural residential; (d) very rural; and (e) ski-oriented.

Results: Changes in Vermont Farms and Farmland, 1969–2017 and Policies to Control Land Fragmentation

Changes in agriculture are the main driver of fragmentation and landscape change (Primdahl and Swaffield 2010). In 1969, shortly before the passage of Act 250, Vermont had

Table 1. Number of farms, change in number of farms, land in farms, the change in land in farms, 1969–2017.

Year	Number of farms	Absolute change	Percentage change	Land in farms (hectares)	Absolute change (hectares)	Percentage change
1969	6,874	–	–	766,200	–	–
1974	5,906	–968	–14%	667,000	–99,200	–13%
2002	6,571	+665	+11%	497,964	–169,032	–25%
2017	6,808	+237	+3.6%	477,375	–20,589	–4%

Source: U.S. Bureau of the Census (1971, 1976), U.S. Department of Agriculture (2004, 2019).

6,874 farms covering 766,200 hectares (see Table 1). By 1974, the number of farms had fallen by 968 or 14% and land in farms had decreased by nearly 100,000 hectares or 13%. These results suggest that Act 250 initially had little effect on the exodus of farmland to other uses. By 2002, there were slightly fewer farms than in 1969, but land in farms had declined by almost 270,000 hectares or 35%, equal to about 11% of the entire state. The addition of preferential assessment of agricultural land in 1980, local agricultural zoning in the 1980s and 1990s, and farmland preservation after 1977, along with Act 250, seemed unable to stem the loss or slow the rate of agricultural land conversion. One measure of farmland fragmentation was a sharp decline in average farm size from 113 hectares in 1974 to 76 hectares in 2002. Not only was a large amount of farmland being converted to other uses, but much of the farmland was being subdivided into smaller farms, hardly a positive trend for a dairy-oriented farm economy.

By 2017, however, farmland loss and fragmentation had markedly slowed. There were 6,808 farms, a modest 3.6% increase from 2002, and land in farms fell by only 20,589 hectares. The average farm size had declined only slightly to 70 hectares. The top 1,077 farms, with sales of more than \$100,000 a year, accounted for 91% of all Vermont farm products sold (USDA 2019).

Town-level agricultural zoning remained weak, however. We reviewed the agricultural zoning in 29 agricultural-oriented towns and found that only three towns have agricultural zoning with a minimum lot size of 10 hectares; the large majority of agricultural towns have minimum lot sizes of two hectares or less, in effect, encouraging rural residential development and land fragmentation. Enrollment in the state’s preferential assessment for taxing agricultural land rose significantly from its beginning in 1980 to 240,000 hectares enrolled by 2000. The amount of agricultural land enrolled has been virtually flat since 2000, and less than half of the state’s agricultural land is enrolled in Current Use (Vermont Department of Taxes 2020, 18). The preferential property tax assessments in 2020 were a very low \$955 per hectare for agricultural land (Vermont Department of Taxes 2020, 19). Farm buildings enrolled in Current Use are exempt from property taxes; they were worth over \$300 million in 2020. We suggest that the low level of land taxation provided by the Current Use Program has helped to retain some agricultural land in parcels of 10 or more hectares.

A leading reason for the retention of farmland after 2002 appears to be the farmland preservation efforts of the Vermont Land Trust and the Vermont Housing and Conservation Board along with the flow of federal farmland preservation funds to Vermont (VHCB 2019). The Vermont Land Trust and the VHCB have worked

cooperatively to preserve more than 1,000 farms and 84,000 hectares of farmland (Moore 2021). VCHB funding from state and federal sources has resulted in the preservation of more than 65,000 hectares and 700 farms (VHCB 2021). The amount of farmland preserved exceeded the amount of farmland lost between 2002 and 2017 with over 31,000 hectares preserved compared to 20,589 hectares lost (Moore 2021; USDA 2019). This result tends to support our contention that farmland preservation efforts are the main reason for the decrease in the rate and amount of farmland loss over that time period.

The Change in Small Farms, 1969–2017 and Town Parcel Data, 2018

Changes in the number of small farms of 4–20 hectares are a measure of the fragmentation of agricultural land. We first analyzed the change in the number and land area of small farms from the Census of Agriculture. We studied whether there is a connection between the growth of small farms and the creation of small parcels of rural land by county.

Between 1969 and 2017, the number of farms of 4–20 hectares increased by 1,389 covering 14,548 hectares to 1,924 farms and 19,278 hectares (U.S. Bureau of the Census 1961; USDA 2019). Meanwhile, the number of farms >20 hectares fell from 6,241 to 4,010 or 36% and the amount of farmland on these farms declined by 304,201 hectares or 27% (U.S. Bureau of the Census 1961; USDA 2019). By 2018, there were a total of 61,365 rural lots of 4–20 hectares covering 505,847 hectares (Vermont Agency for Digital Services 2020). These rural lots took up 21% of the state land area. Farms made up a very small proportion of these lots. There was 25 times more non-farmland in 4- to 20-hectare lots than in similar sized farms lots, after subtracting the 4- to 20-hectare farms. More alarming is the fact that there is more land in 4- to 20-hectare non-farm lots—486,568 hectares—than in all Vermont farms: 477,375 hectares. This result suggests considerable low-density, large-lot rural residential sprawl and suggests that rural residential uses can generally outcompete small farms for land.

Distribution of Lots and Land Area in the Five Types of Rural Towns

We next looked at the number and amount of land by lot size in individual towns according to five types of towns: (1) agricultural; (2) residential; (3) rural residential; (4) very rural; and (5) ski-oriented (see Figure 2). These towns reflect the changes in Vermont from a remote rural region in 1959 to a mix of rural residential towns, a cluster of agricultural towns in three counties, a metropolitan area designated in 1980 encompassing three counties, and ski towns easily accessible to visitors from out of state (see Figure 2).

We defined an agricultural town as one having <3,000 residents and more than 1,600 hectares of agricultural land enrolled in the state Current Use program for property taxation. Given that a town is typically 10,000 hectares, an agricultural town has more than one-sixth of its land in agriculture and has a low population with limited demand for residential development. A residential town has a population of more than 3,000 residents. A rural residential town has between 1,000 and 3,000 people and <1,600

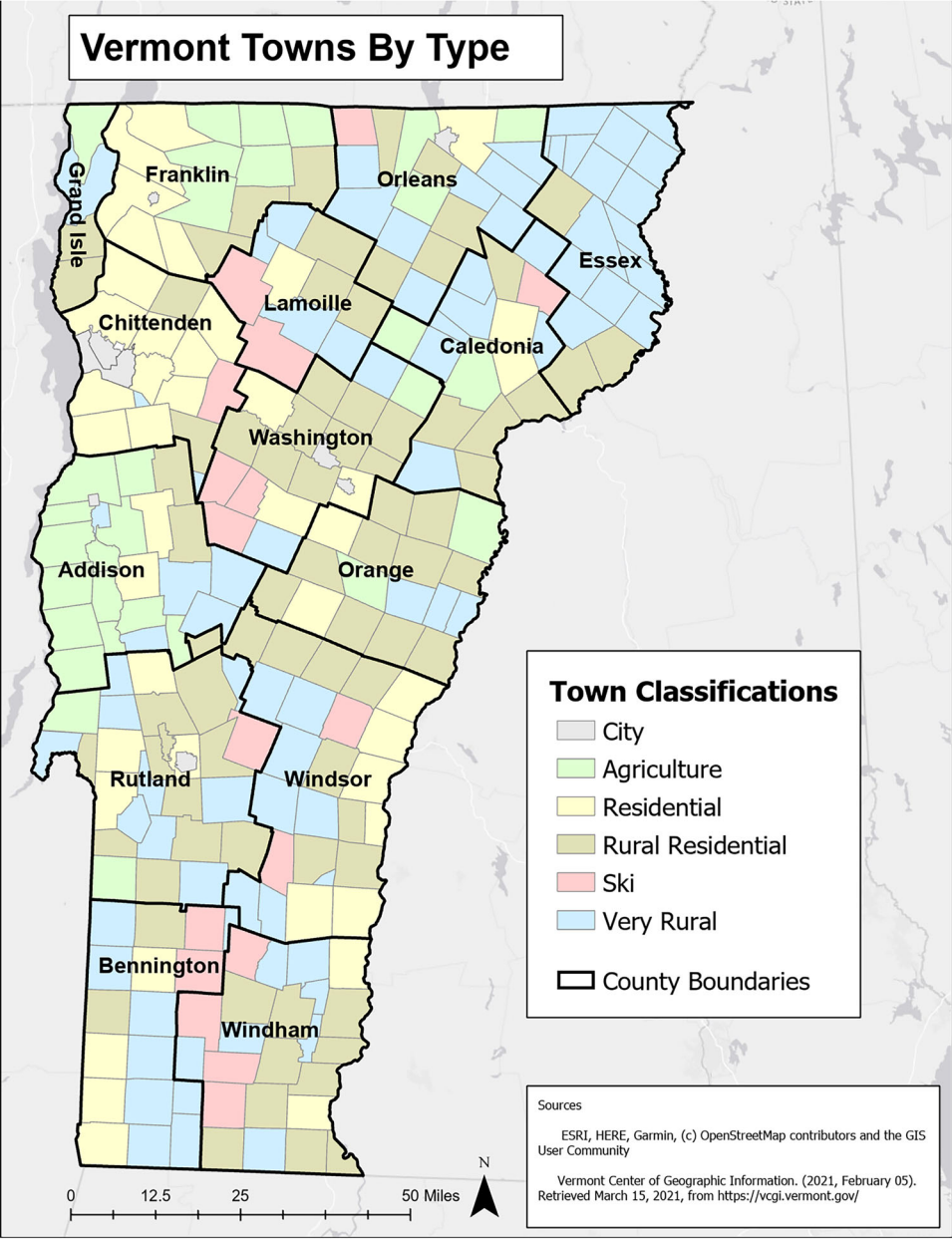


Figure 2. Vermont towns by type.

hectares of agricultural land enrolled in the Current Use Program. A very rural town has fewer than 1,000 people and <1,600 hectares of agricultural land enrolled in the Current Use Program (see Vermont Department of Taxes 2020, 24–32). A ski town contains a ski resort or is adjacent to a town with a ski resort. We categorized the state’s 242 towns as 29 agricultural, 43 residential, 75 rural residential, 78 very rural, and 17 ski towns.

Table 2. Distribution of lots and land area in hectares by type of town, 2018.

Type of town	Lots of 1.2–3.9 hectares	Area in 1.2–3.9 hectare lots	Lots of 4–10 hectares	Area in 4–10 hectare lots	Lots of 4–20 hectares	Area in 4–20 hectare lots
Agricultural	5,116	12,543	5,388	30,550	7,252	58,976
Residential	17,940	48,335	12,001	71,887	17,330	143,045
Rural residential	16,021	37,865	13,942	82,482	19,563	167,330
Very rural	7,041	17,044	7,718	45,499	11,267	88,648
Ski	6,630	15,727	4,337	26,037	5,953	47,848
Total	52,748	131,514	43,386	256,465	61,365	505,847

Note. 1 hectare = 2.47 acres.
Source: Vermont Agency for Digital Services, Parcel Program 2020.

We used data from the Vermont Parcel Program to identify whether there is a pattern in the number and amount of land in lots of different sizes in the five types of towns (see [Table 2](#)). Not surprisingly, residential towns have the most lots and land in the 1.2–3.9 hectares category, followed by rural residential towns. The 29 agricultural towns had the fewest lots and land area in that category. Rural residential towns had the most total lots and land in both the 4–10 hectares and 4–20 hectares categories with residential towns second. Ski towns had the second highest average number of lots per town (390) after residential towns (427), a reflection of the demand for lodging near ski resorts. We would expect land prices to be higher in more densely settled residential towns and in ski towns where vacationers from out-of-state generally have greater ability to pay than local residents. The prevalence of 4–20 hectare lots in very rural and agricultural towns was not unexpected given that land costs in those towns tend to be lower because of a more remote location and are likely to be held for longer periods of time.

Nearly 40% of all towns (94) had more 4- to 10-hectare lots than 1.2- to 3.9-hectare lots. Very rural, rural residential, and agricultural towns made up the large majority (87) of these towns. However, 131 of 242 towns had twice as much land in 4- to 10-hectare lots than in 1.2–3.9 hectare lots. These numbers suggest considerable fragmentation of the rural landscape into large lots with limited farming potential in a dairy-dominated agricultural economy.

Discussion

This study of rural and farmland land fragmentation in Vermont exceeds previous US studies by analyzing the degree and drivers of fragmentation over time, the state-wide scale of the land fragmentation, efforts to control farmland fragmentation, and the detailed parcel data on fragmentation.

Kjelland et al. (2007) studied rural land fragmentation in Texas. They noted that the decrease in rural property sizes has come from changes in the demand for rural land for non-farm uses along with an increase in the number of willing sellers resulting from lower financial returns to agriculture, the rise in the age of rural landowners, and family dynamics and expenses affecting intergenerational land transfers. This study did not use detailed parcel data, nor did it identify different types of rural towns, or assess efforts to manage land fragmentation.

In future fragmentation studies, it would be useful to know the configuration and exact location of the land parcels to determine the shape of the parcels in the landscape and the degree of scattering or clustering of smaller parcels. Irregularly shaped parcels can hinder land use and land management. Scattered smaller parcels suggest the potential for more conflicts with neighboring farming operations.

Pros and Cons of Land Fragmentation

The fragmentation of rural land is often thought to be detrimental to farming. Healy and Short (1981) noted that increasing land prices along with residential development in the countryside could fragment the land base into lots that were inefficient for farming. They further observed that once residential development had fragmented the land base, it was nearly impossible to re-configure land into larger parcels for farming. As farmland is divided into house sites for local residents or second homes for part-time residents, the non-farm value of the land increases beyond what a farmer can afford to pay for the land thus inhibiting the expansion of farming operations and raising the barrier to entry for new farmers (Daniels and Bowers 1997; Frank and Hibbard 2017; Kjelland et al. 2007). It is important to note that fragmentation of the agricultural land base can influence land preservation priorities (Wear, Pye, and Riitters 2004). The more fragmented the landscape, the higher the cost of farmland preservation, the greater the likelihood of conflicts between farming operations and non-farm neighbors, and the lower the likelihood of preserving farmland in large contiguous blocks (Stoms et al. 2009; Daniels and Bowers 1997). Kjelland et al. (2007) also suggest the need to project fragmentation rates into the future for specific locations to identify where farms may be in jeopardy.

Land fragmentation often reflects the higher valued uses of residences and second homes compared to agricultural uses. For example, Vermont is a very popular second home market; 17% of Vermont's housing stock is seasonal second homes, one of the highest rates among all US states (Black-Plumeau 2022). Many farmers have been able to sell land parcels to fund their exit from agriculture in an era of dwindling dairy farm numbers. Moreover, some fragmentation in Vermont has been masked by the increase in forest cover, which has reached about 80% of the state (Lapping and Guay 2013). The large decrease in the amount of land in active farming since 1959 has been a major factor in the return of forests. Farmland that returns to the forest may have benefits for water quality, carbon storage, and biodiversity. There has also been a growth in the number of small nondairy farms in Vermont, suggesting greater diversification of the farm economy. Smaller parcels are more affordable to young and beginning farmers.

Policies and Programs to Discourage the Fragmentation of Farmland

State and town governments in Vermont and other states will continue to use land use regulations, property tax incentives, zoning, and land preservation to shape the rural landscape. But there is no guarantee that these programs will be able to ensure that agriculture can remain economically viable and continue to provide a working rural landscape. Federal farm subsidy policies are likely to prove more powerful, but federal

support for dairy farming has declined over the past 20 years (Schnepf 2021). The number of dairy farms in Vermont shrank from 4,017 farms in 1969 to 636 farms in 2020 (Hoffer 2021). This is part of a national trend that has seen the number of licensed dairy herds fall by more than half, from more than 70,000 in 2003 to just over 34,000 in 2019 (USDA 2020).

The data on land fragmentation at the town level lend some support to the contention that Act 250 may have incentivized the creation of 4- to 10-hectare lots. More than one-third of Vermont towns (94) had more lots in the 4- to 10-hectare category than in the 1.2- to 3.9-hectare category, and were nearly all rural residential, very rural, and agricultural towns. Also, more than half of all towns had more than twice as much land in 4- to 10-hectare lots than in 1.2–3.9 hectare lots.

A large amount of rural land in 4- to 20-hectare parcels is a key indicator of land fragmentation. Compared to 1959 when nearly half of Vermont was on farms, the amount of nonagricultural land in 4- to 20-hectare parcels now exceeds the total amount of agricultural land in the state. Individual towns appear to lack the capacity to control land fragmentation, partly because of weak zoning that enables fragmentation. Stronger land use controls, such as a 10-hectare minimum lot size on farmland would likely have slowed the pace of fragmentation and the amount of farmland converted to other uses.

The Current Use program has helped to restrain property taxes on agricultural land, but only half of the farmland in Vermont is enrolled in the Current Use Program. This suggests that many owners of agricultural land are avoiding the Current Use Program because of the tax penalty it imposes when farmland is sold for non-farm uses. The general consensus is that preferential farmland taxation provides small and short-term benefits (Liu and Lynch 2011).

Vermont's farmland preservation efforts have retained a large amount of agricultural land: more than 84,000 hectares since the late 1970s. Even so, the amount of farmland shrank by 223,000 hectares from 1978 to 2017 (USDA 2019). But farmland preservation programs have been shown to slow the rate of farmland loss in six Mid-Atlantic states (Liu and Lynch 2011). This appears to be the case in Vermont as well. Between 2002 and 2017, the rate of farmland loss slowed, and the amount of farmland preserved exceeded the amount of farmland that was converted to other uses. This result tends to support the conclusion that farmland preservation has had a major effect on slowing the fragmentation of farmland in Vermont.

Twenty-one of the 29 agricultural towns we identified are located in Addison, Franklin, and Orleans Counties, Vermont's three leading counties in the value of agricultural production, accounting for 59% of the state's \$781 million in farm output in 2017 (USDA 2019). In addition, the three counties contain 61% of the preserved farmland in the state (Moore 2021). Thus, the majority of the preserved farmland is located in the three counties where Vermont's agriculture is concentrated.

Conclusion

The Vermont case study provides several lessons about rural land fragmentation, farmland loss, and attempts to retain land in active agriculture. Several researchers in the US

and Europe have noted that the fragmentation of more remote rural land signals a change in local land use from extensive to intensive uses, away from agriculture to residential and non-farm commercial uses. Vermont has experienced dramatic rural land fragmentation since 1959. Contributing factors include population growth, improved highway access, the popularity of vacation homes and skiing among visitors from out-of-state, a preference for ex-urban living, and the decline in the viability of small dairy farms.

The study provides indicators of landscape fragmentation by parcel size, agricultural and nonagricultural land uses, and type of town. We recommend that any country, state, town, or region follow the methods presented here of acquiring and comparing rural parcel data and agricultural census data—and regularly update the data—to identify trends in farmland loss and rural land fragmentation.

Vermont's efforts to manage farmland fragmentation have evolved over time as a market approach proved inadequate in the 1959–1969 era. Regulation of land subdivision, either through Act 250 or local zoning, has been weak. Stronger agricultural zoning with a minimum lot size of at least 10 hectares, as practiced in several other states, would help limit farmland fragmentation, but this has not been politically popular in Vermont. Farmland preservation through the purchase of development rights has shown some success and will require continued funding. Policy makers in the USA and other countries must recognize that limits on farmland division, farmland preservation or farm subsidies, and the preferential taxation of farmland can help to slow farmland fragmentation but cannot ensure the long-term economic viability of farms and the continuation of a working rural landscape.

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Data Availability Statement

Data for this study are available from the USDA (2019), U.S. Bureau of the Census (1971), and Vermont Agency for Digital Services (2020).

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