Subsurface drainage and land use in New Brunswick

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Milburn, P. and Gartley, C. 1988. **Subsurface drainage and land use in New Brunswick.** Can. Agric. Eng. **30**: 13–17. Agricultural subsurface drainage activity in New Brunswick from 1947 to 1986 is reviewed and a commodity profile of subsurface drainage clients is presented. The results of a survey of farmers responsible for 50% of the total subdrainage installation for the period 1978–1984 inclusive show that 60% of the drainage was for forage production, 30% was installed on land that was previously wooded, idle, or in permanent pasture, and that 99% of the farmers felt that subsurface drainage had either improved or greatly improved production efficiency on their farm.

INTRODUCTION

The potential agricultural land base of the Atlantic Region and its inherent soil limitation have been well described (Nowland 1975). According to Canada Land Inventory (CLI) data, the single most important limitation to agricultural productivity in New Brunswick, other than low natural fertility, is the extent of wet and slowly permeable soils (Parks 1977). Of New Brunswick's approximate 7 million ha, 3.5 million ha of CLI class 2, 3, and 4 soils are rated suitable for agriculture. By considering factors such as distance to and availability of markets, settlement patterns, and the amount of presently cleared land, this potential area is reduced to 1.3 million ha of CLI class 2, 3, and 4 "agriculturally blocked land", which includes existing cleared land (Nowland 1975). Approximately 95% of the 1.3 million ha is CLI class 3 and 4 (Arbour 1981).

The total area of New Brunswick's current agricultural land holdings is 0.44 million ha, with 0.19 million ha classified as improved (Census of Canada 1981). "Improved" in this case refers to cleared land subject to minimal agricultural management in recent years such as seeding, fertilization, and cultivation. Past estimates of the land drainage requirement of presently cleared land range from 0.04 to 0.05 million ha (Broughton 1976; Parks 1977; Irwin 1985).

Nowland (1975) indicates that 48% of class 2, 3, and 4 soils in the Atlantic Region experience problems with excess water; two-thirds of these soils exhibit undesirable subsoil structure and/or low subsoil permeability. From present soil inventory data, Rees and Chow (1986, personal communication, Agriculture Canada Research Station, Fredericton, New Brunswick) estimate that 88% of New Brunswick's agriculturally blocked land is developed from glacial till, and that approximately 50% of all New Brunswick class 3 and 4 soils have excess soil moisture problems. Forty-five percent of the blocked agricultural land is derived from compact basal till or a thin mantle of loose till underlain by compact till; these soils generally exhibit 0.2–0.6 m of friable, permeable material over the compact subsoil, and a subsoil density of 1.7–2.0 g/cm^3. A review of New Brunswick's existing soil inventory is presented by Fahmy et al. (1986).

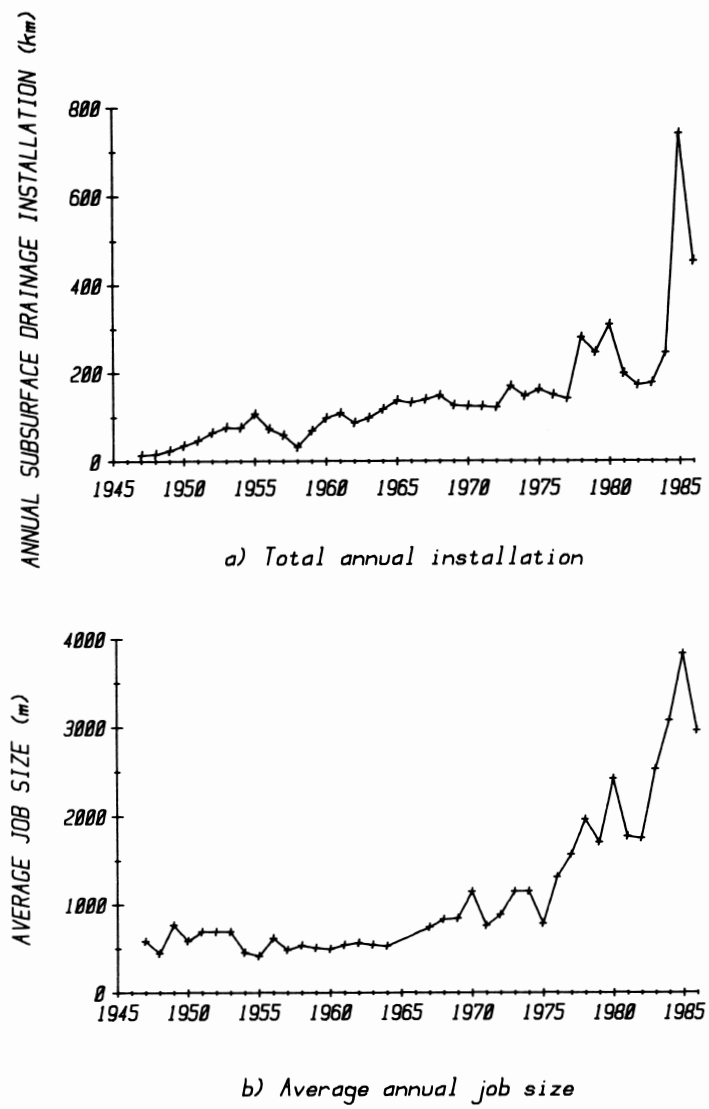

Figure 1. Subsurface drainage installation in New Brunswick, 1947–1986.

Though early attempts at drainage improvement included open ditching, ridging and the installation of subdrains by hand, the adoption of the subsurface drainage technique began in earnest in 1947 when the New Brunswick Department of Agriculture purchased its first mechanized tile drainage machine (Roberts 1947). Its use has increased substantially, despite min-

imum drainage research in the region (Milburn 1987) and the severity of the shallow, compact soil regime described above. As a prelude to research on subdrainage performance on New Brunswick glacial till soils, the purpose of this paper is to document the nature and extent of past subsurface drainage activity in New Brunswick, and to determine the agricultural impact of subsurface drainage improvement as perceived by New Brunswick farmers. The latter was achieved by interviewing 83 producers who collectively installed 50% of the subsurface drainage in the Province for the period 1978–1984 inclusive. Their farmlands are distributed throughout the Province over many soil types.

PAST DRAINAGE ACTIVITY

Drainage records and commodity information presented in this section were provided by the Soil and Water Section, Agricultural Resource Development Branch, New Brunswick Department of Agriculture.

Figure 1(a) shows the annual subsurface drainage installation, 1947–1986. Note the increases in 1973, 1978 and 1985, which correspond to the initiation of 5-yr Federal-Provincial agricultural agreements which cost-shared the installed cost of drainage with farmers on an approximate 50–50 basis. Government-owned drainage machines installed all subdrainage until 1977; in 1978 private contractors began operation, accounting for 61% of all installations that year. Private contractors installed 90% of the annual total by 1981; the last government-owned drainage machine ceased operation in 1983. The first contractor-owned trenchless plow began commercial operation in the Province in 1984. Figure 1(b) shows an increase in average job size since private contractors became the source of subdrain installation in 1978. This trend has been accompanied by a substantial increase in systematic subdrainage systems.

Most of the subdrainage prior to 1978 was random; potato producers were the dominant user group during the 1950s and 1960s (Gilchrist, E. 1986, personal communication; Agricultural Engineering Branch, N.B. Department of Agriculture and Rural Development, Fredericton, N.B.). Figure 2 shows that for the period 1978–1986, dairy producers were the largest user group.

There are presently three trenchers and three trenchless plows operating in New Brunswick. Since 1984 trenchless plows have installed most of the subsurface drainage systems.

FARMER QUESTIONNAIRE

The purpose of the farmer questionnaire was to determine land use prior to and following subdrainage and to determine the perceived effect of subsurface drainage on overall farm productivity. A similar approach was used by Fausey et al. (1982) in Ohio to determine the kind and frequency of maintenance performed on subsurface drainage systems for the period 1965–1975. Fausey's questionnaire was mailed to 511 individuals; 283 responses were received. Because of the smaller sample size of the survey described herein, it was deemed important that each individual respond. Personal interviews were therefore arranged.

To obtain information relevant to current agricultural practices and representative of field scale drainage, it was decided to interview only those farmers who had installed more than 4500 m of subdrains during the period 1978–1984. Eighty-three producers satisfied this criterion collectively representing approximately 50% of the 1.62 million m of subdrainage installed in New Brunswick during the period. The average amount of subsurface drainage installed by each farmer was 9200 m.

Figure 3(a)shows the commodity groups and associated subsurface drainage represented by the farmer sample. Figure 3(b)

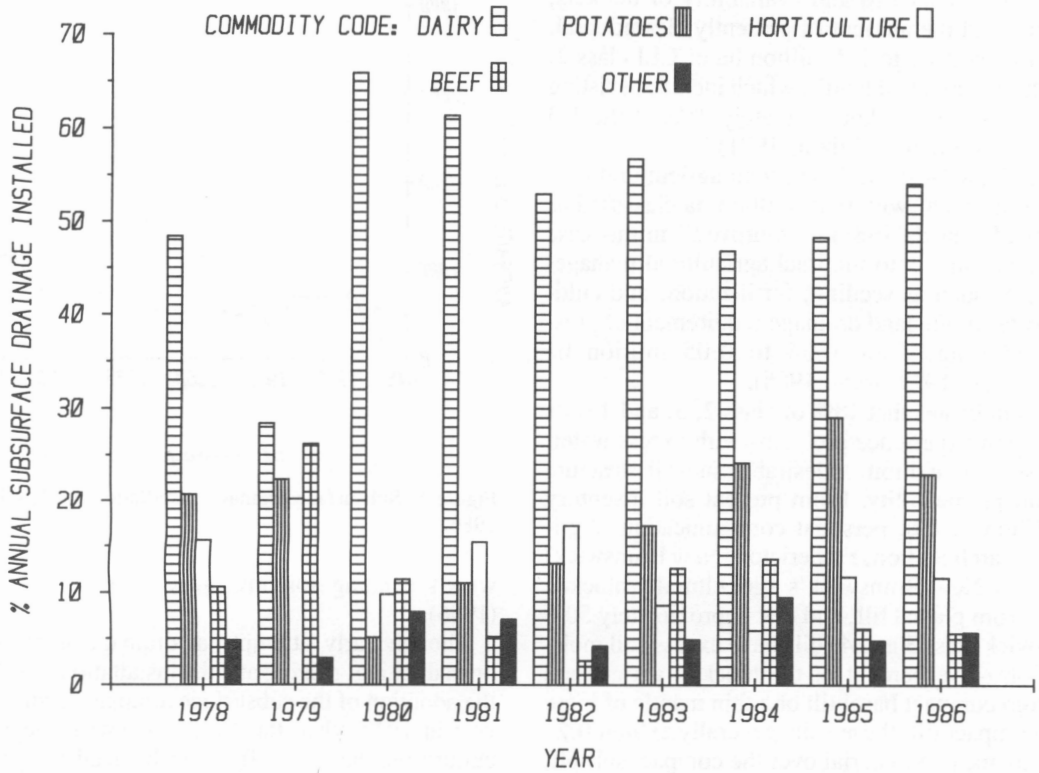

Figure 2. Subsurface drainage utilization by commodity groups, 1978–1986.

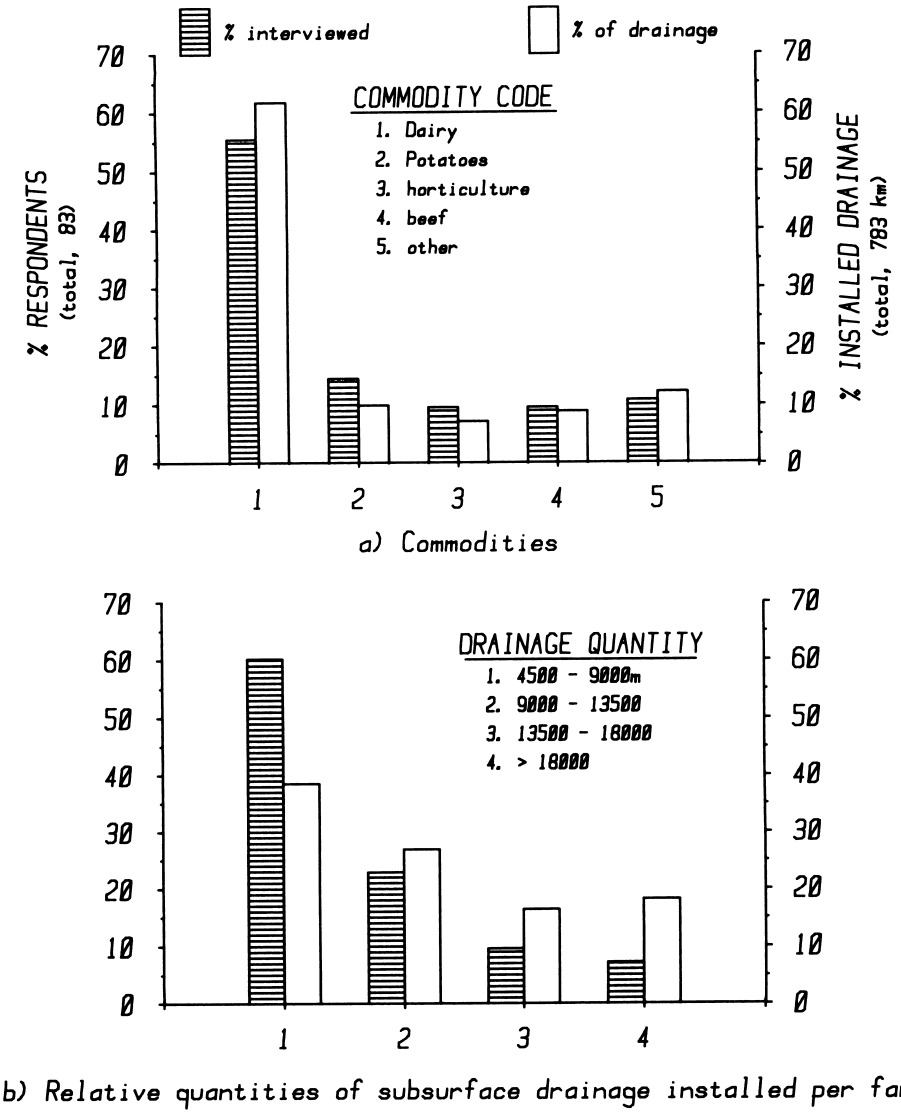

Figure 3. Commodity affiliation of farmers interviewed and associated subsurface drainage installed, 1978–1984.

shows that 61% (50 producers) had installed from 4500 to 9000 m of drainage tubing, 23% from 9000 to 13 500 m and 7% greater than 18 000 m. It was felt that this group amply represented legitimate use of subsurface drainage in the Province and that the information collected would provide valid insight into the effects of subdrainage on New Brunswick agriculture.

Interviews were conducted during 1986 by the authors or engineering staff of the New Brunswick Department of Agriculture. A farmer's experience with working subsurface-drained land was therefore limited to between one and nine growing seasons, depending on when during the 1978–1984 period he began drainage improvements and when he was interviewed.

A predesigned multiple choice questionnaire was employed; those interviewed were able to respond easily with little or no explanation required by the interviewer. Several questions served to further qualify the response of the surveyed group. For example, 71% of those surveyed had more than 80% of the drainage on their farm installed in a systematic grid; 82% had accurate records (maps) of the installed drains, which represented 85% of the drains installed by the group; approximately 80% of the drainage systems were installed by wheeled trenchers; 65% had installed subsurface drainage systems prior to 1978, the majority of which were random systems of combined totals less than 6000 m; 45% have installed mostly systematic drainage systems since 1984.

SURVEY RESULTS

Land use

Farmers were asked to identify the dominant land use prior to drainage of those lands subject to drainage improvement in the period 1978–1984. The response categories provided were: newly cleared; idle land, not used due to poor drainage condition; pasture only; passive production, as drainage conditions permitted; cropped regularly; and other. Only one category which most represented the predrainage condition was selected. The results are shown in Figure 4(a). Fifty-seven percent (representing 56% of the total drainage installed) indicated that the land was previously in passive production. Twenty-five percent of the drainage (24% of respondents) was installed on idle or pasture land. Only 10% was installed on land that was already cropped regularly. These results suggest that the majority of subsurface drainage is being employed to overcome very obvious wetness limitations that affect crop selection, traffic-

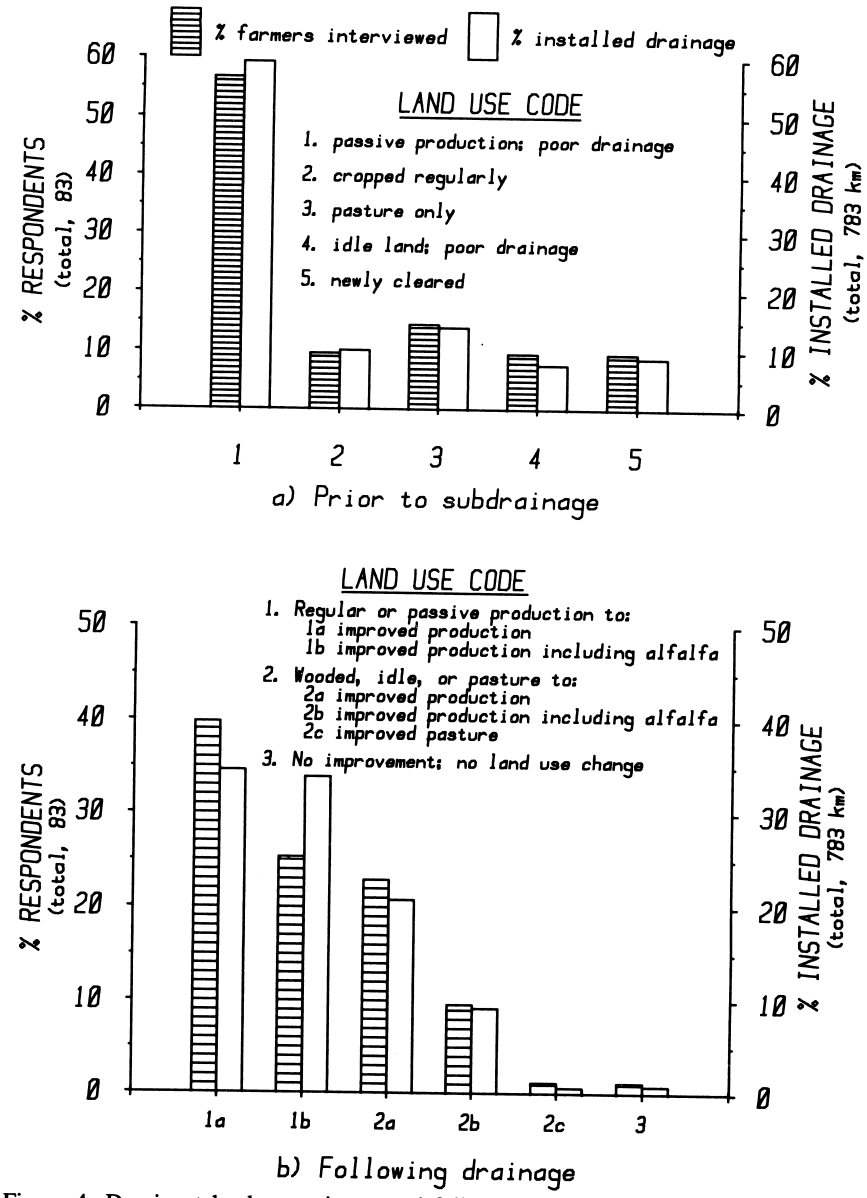

Figure 4. Dominant land use prior to and following subsurface drainage according to farmer survey. (Farmers interviewed represent approximately 50% of total New Brunswick subsurface drainage installation for the period 1978–1984.)

ability, length of growing season, and overall farm efficiency, rather than to solely boost yields.

Similarly, to determine dominant land use after drainage improvement, the response categories shown in Figure 4(b) were provided. Thirty-one percent had changed their land use from wooded, idle, or pasture to improved production (code 2a, 2b); 23% of these were producing alfalfa on some of the improved land (code 2b). Sixty-six percent went from passive or regular production to improved production; 62% of these were producing alfalfa on some of the improved land.

Drainage improvement and production efficiency

When asked whether the wetness condition of land drained in the period 1978–1984 was not improved, improved, or greatly improved compared to its original condition, 74% of the producers representing 78% of the drainage installed indicated that it was greatly improved. One producer representing 1% of the drainage installed experienced no improvements. Poor grade control and soil compaction was the stated expected cause of the poor performance.

When asked whether the investment in subsurface drainage had greatly improved, improved, or not improved production efficiency on their farm, 59% and 40% replied that production efficiency was greatly improved and improved, respectively. These responses correspond to 62 and 38% of the total drainage installed by the group. "Production efficiency" was defined as encompassing all aspects of production such as trafficability, reduced downtime, range of crops grown, timeliness of operation, length of growing season, and yield, rather than yield alone.

Only 4% of the producers indicated that drainage improvements were now completed on their farm. Sixty-eight percent of those surveyed, representing 73% of the drainage installed by the group, felt that future drain spacings should be similar to those already employed on their farm. Twenty-four percent

felt that future drain spacings should be narrower. Nominal drain spacings in New Brunswick range from 13 to 18 m.

SUMMARY AND CONCLUSIONS

A general description of New Brunswick subsurface drainage activity and associated agricultural effects is presented based on historical records and a farmer survey which encompassed 83 farmers and 50% of the subsurface drainage installed during the period 1978–1984. The survey results are not soil-type specific nor can the information be used to identify or solve specific soil-water problems. However, the character of the interrelationships among subsurface drainage, land use, and agricultural productivity is illustrated, and farmers' opinions on various aspects of subsurface drainage are revealed. These factors should be considered when formulating future land-related research or extension programs.

The following observations are drawn from the data presented:

(1) The availability of private drainage contractor services, together with appropriate government-sponsored cost sharing programs, increases the quantities of subsurface drainage installed.

(2) Dairy producers are currently the largest user group of subsurface drainage in New Brunswick, accounting for approximately 50% of the total subdrain installation over the period 1978–1986.

(3) Most subsurface drainage in New Brunswick is being employed to rectify obvious wet conditions rather than to fine tune already aggressive crop management systems. Only 10% of those surveyed reported that their land was cropped regularly prior to drainage improvement.

(4) Most producers feel that subsurface drainage is having a positive effect on their farming operations. Ninety-nine percent indicated that production efficiency on their farm was either greatly improved (59%) or improved (40%) because of the investment in subsurface drainage.

(5) Future drain spacings should be similar to or narrower than those already installed. (This assumes no use of secondary drainage treatments.)

(6) A large portion of the farmers interviewed are producing alfalfa on at least some of their subdrained land.

(7) There is more land requiring drainage improvement in New Brunswick. Only 4% of those interviewed felt that drainage improvements on their farms were now completed.

Future multidisciplinary research and development by Agriculture Canada and the New Brunswick Department of Agriculture will attempt to quantify and improve the performance of drainage systems on major New Burnswick soils, and will investigate the productive potential of compact, basal till soils following drainage improvement and appropriate secondary treatments, with emphasis on forage/legume production.

ACKNOWLEDGMENT

The excellent assistance of engineering staff of the New Brunswick Department of Agriculture is gratefully acknowledged.

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