seines sicher sehr hohen Alters, im oberen Teil der Hänge mit Hangneigungen um 30° noch sehr steil und bietet der Vegetation daher nur geringe Ansatzmöglichkeiten. Durch die den Kegel umlaufenden Erosionsrinnen werden sogar an der NW- und SE-Seite die unteren Teile seiner Unterhänge steilgehalten. Mit dieser Art der Beschreibung lassen sich für alle anderen Kegel, mit Ausnahme der jungen Kegelreihe des Ausbruchs von 1865, die noch keine Differenzierung aufweist, ähnliche oder anderslautende Befunde erarbeiten.

Als ein wichtiges Ergebnis dieser Kartenbeschreibung kann man anführen, daß erst eine eingehende Interpretation des bei der Geländeuntersuchung erstellten Karteninhalts in seiner Anordnung, des Deckungsgrads, der Häufigkeit und Form der Kartiereinheiten neue Befunde ergibt oder Geländeergebnisse bestätigt.

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SUGAR-BEET PRODUCTION IN THENORD DÉPARTEMENT OF FRANCE DURING THE NINETEENTH CENTURY

With 8 figures and 4 tables

H. D. Clout and A. D. M. Phillips

Zusammenfassung: Zuckerrübenproduktion im französischen Departement Nord im 19. Jahrhundert

Der Aufsatz zeigt die Entwicklung einer auf der Landwirtschaft basierenden Industrie während des 19. Jh. auf, und zwar am Beispiel des Zuckerrübenanbaus und der Standorte und Zahl der Zuckerfabriken. Trotz des begrenzten Untersuchungsobjektes werden die Beziehungen zwischen Anbau und Verarbeitungsindustrie augenscheinlich. Obwohl die Zuckerrübenproduktion „künstlich" eingeführt wurde und ihr Bestand und ihre Bedeutung den Wechsel der Zölle und Steuern nachvollzog, war ihre Übernahme durch die Bauern abhängig von den ökonomischen Bedingungen. Die Ausbreitung der Anbaufläche hing von den physisch-geographischen Verhältnissen und der Möglichkeit ab, die neue Frucht in die bestehenden Anbausysteme einzufügen. Ihre Übernahme in das landwirtschaftlich fortschrittliche Departement Nord bestätigt dies ebenso wie die dortigen regionalen Unterschiede ihrer Verbreitung. Während des größten Teils des Jahrhunderts gab es in den Weidegebieten des Avesnois und Flanderns keinen Zuckerrübenanbau, dagegen konzentrierte er sich in den Ackerbaugebieten um die Hauptindustriezentren Douai, Lille und Valenciennes. Dies änderte sich während des letzten Viertels des Jahrhunderts, und zwar durch eine zunehmende Anbauverdichtung im Cambrésis. Eine ähnliche Entwicklung nahmen die Standorte der Zuckerfabriken. Die Zahl

der Betriebe hing zwar teilweise von den durch Zölle und Steuern beeinflußten Wirtschaftsverhältnissen ab, doch zeichnete sich auch eine Konzentrationsbewegung ab, d. h. die Schließung kleiner und der Bau einer begrenzten Zahl großer, technisch fortschrittlicher und rentabler Betriebe. Trotz der Verbesserung der Verkehrsbedingungen innerhalb des Departements reflektierten die Standorte der Fabriken die jeweilige Ausdehnung der Anbaugebiete.

Introduction

By the end of the eighteenth century, the newly-formed *département* of the Nord contained one of the most advanced agricultural systems in Europe which allowed it to support high population densities, a well-developed urban life and a wide variety of manufacturing activities, many of which depended directly on locally-produced crops such as flax, hops and colza. Beet, as a source of sugar, was soon to be added to that list and was to make a major contribution to the further advance of both agricultural and industrial activities in the *département*. This paper attempts to trace the introduction and changing importance of beet production for sugar in the Nord throughout the nineteenth century.

In spite of the importance of the nineteenth century sugar-beet industry of the Nord, certain difficulties exist in examing its history. The growing of beet for sugar and the development of its related processing industry was largely encouraged by the State in the early years of the nineteenth century in response to the interruption of normal trading conditions. As Clapham noted, 'Sugar-beet growing has been the sport of tariff-makers and international agreements. Its history is exceptional and highly technical' (CLAPHAM, p. 177). The development of the industry and the area devoted to the crop underwent many changes during the century in response first, to modification in international politics and trade, and second, to the march of technical advance and biological progress. Furthermore, the nature of the *département's* archival material places other restrictions on the study. Precise details of the possible linkages between beet growers and sugar factory owners may not be determined, nor is information available on the proportion that beet production occupied in farm income. All that can be studied is the introduction and diffusion of the industry; the area planted with beet for sugar and its changing location; the changing number and location of factories processing beet; the manner in which the crop fitted into agricultural practices, bearing in mind that it could be used for fodder as well as for sugar; and the response of the industry and crop area to changing techniques in beet processing.

Origins of sugar production from beet in France

The adoption of beet growing for sugar production in France depended on particular political circumstances. The critical international situation in the early years of the nineteenth century, and especially the English blockade of French maritime trade, meant that France experienced severe sugar shortages between 1803 and 1810, being cut off from her West Indian sources of cane sugar. Little attention was paid by the French government to beet as a potential source of sugar in the early years of the decade, despite the facts that experiments were conducted using other fruits and plants, and that commercial sugar-beet production had already been attempted in Germany (DE WARENGHIEN, p. 243).

Nevertheless, experiments for the extraction of sugar from beet continued in France and in 1811 a new machine was perfected for cutting and pulping beet and extracting its juice. In the same year, following a decree of 25 March, the Napoleonic government attempted to encourage the growing of beet for sugar production by offering financial assistance. The government urged that 32,000 ha. should be sown with beet throughout the Empire, that processing factories should be opened and that experimental schools be set up with financial help from the State to teach techniques of sugar production from beet (SLICHER VAN BATH, p. 277). To encourage interest in this new venture it was suggested that anyone establishing a sugar factory would stand to make a hundred per cent profit annually. *Département* prefects were given instructions to ensure that targets for beet growing and factory building should be achieved. But the scheme met with limited success.

Early experience in the département of the Nord

Beet were not unknown to farmers in the Nord at the beginning of the nineteenth century, especially to those in Flanders. The *betterave rouge* and the *betterave champêtre* (or *disette*) had been introduced to the region in 1784 by government agents who had distributed seeds. By 1804 beet had entered the complex rotations practised in Lille and Douai *arrondissements* and around Bergues near Dunkirk where they served to nourish man and beast alike (DIEUDONNÉ, p. 426).

After 1810 a new enthusiasm for the production of beet developed and the initiative for cultivating beet for sugar production, as opposed to any other purpose, came largely from urban-based merchants and industrialists. The local agricultural societies in the Nord at Douai and Lille followed closely the progress in sugar extraction made in Germany, the Netherlands, Belgium and in Paris (LENTACKER [1954], p. 325). In addition, successful experiments for improving supplies of seed, developing beet processing and upgrading techniques of sugar extraction were carried out in the Nord in 1810 by staff of the prefecture and private individuals (*A.D.N.*, M 137[17]). During 1811 at least four factories for the extraction of sugar from beet were in existence in the *département*, located at Douai, Lille, Auby and Valenciennes.

Table 1: Area under beet in the Nord, 1811–1867

Arrondissement	1811 Communes	ha	1812 ha	1813 ha	1836 ha	1852 ha	1867 ha
Dunkirk	1	0.34	50	85	700	542	828
Hazebrouck	5	2.83	71	74	580	698	472
Lille	74	160.29	787	947	3109	5981	4220
Douai	113*	210.74*	800*	1011*	—	5162	5250
Valenciennes					4256	7319	7882
Cambrai	7	2.31	60	62	1343	3244	4714
Avesnes	3	0.73	40	41	909	1486	1907
Total	203	377.24	1808	2220	10897**	24432	25273

* Includes Valenciennes ** Total for six arrondissements only

Sources: *Annuaires du Nord* (1812), 151; (1813), 192; (1814), 187; (1837), 363–6; *A.D.N.*, M. 649[1] and M. 650[19]

The 1811 government targets of areas to be sown with beet for sugar extraction were not met anywhere in France, although they came closest to being fulfilled in the Nord. Here 377 ha. out of a projected 400 ha. were sown. The *département* was the leading producer of the crop in 1811, its 377 ha representing 5.5 per cent of the total 6,785 ha. devoted to beet throughout the Empire (DE WARENGHIEN, p. 408; SLICHER VAN BATH, p. 277). But beet production was distributed unevenly throughout the Nord and 98.4 per cent of the total area sown with beet was located in the central part of the *département*, containing the cities of Lille, Douai and Valenciennes (Table 1). Douai *arrondissement* was in the lead with 211 ha. given over to this crop in 130 *communes*. Such a concentration resulted first from the fact that beet was already known in the central parts of the Nord and second, because of strong encouragement from the Douai agricultural society and from the sub-prefect for the new crop to be grown. Sub-prefect Maschet wrote optimistically to mayors of *communes* around Douai extolling the virtues of the crop. 'It is not necessary to spell out the advantages of this crop to farmers in the *arrondissements*. They are aware that almost all types of soil are suitable for this crop which offers an unfailing success; that it offers an excellent foodstuff for livestock; and that it improves, cleans and usefully prepares the soil before the cereal crops are planted' (PIÉRARD, pp. 311–12). In addition, he noted that a large amount of enriched material was returned to the soil with the beet's abundant leaves.

In these early years of production, a sugar equivalent of only about 3 per cent of the total weight of processed beet could be achieved. As a result, vast quantities of beet had to be carted to the sugar works to obtain only a small return. This fact imposed certain restrictions on the location of beet production. In the Nord, beet production became of particular interest to farmers with properties cloce to those urban centres where the first sugar works were sited. Not surprsingly beet was grown in proximity to highways leading to Lille, Douai and Valenciennes. Indeed, an early instruction stipulated that the new crop should be developed '... by preference close to factories, on the banks of rivers and canals, and close to large towns where capitalists are to be found who would develop this new industry'. (*A.D.N.*, M. 581[45]).

The nature of beet cultivation influenced its rate of adoption. Successful beet production in the sense of growing roots with a high content of sugar required the purchase of good quality seeds and the abundant use of manures, together with intensive ploughing, weeding and thinning out. In short it exerted requirements which could only be satisfied in areas of progressive farming: yet beet production could provoke even greater agricultural advance in such areas. Such exigencies proved impossible to realise on many farms in the early years of beet production. Some of these requirements were not even recognised as being essential until after several years of trial and error.

The 1811 experiment was a failure nationally, with only 21 per cent of the proposed area being planted. It was an example of inefficient and ill-prepared central government initiative, lacking any follow up in the provinces (SLICHER VAN BATH, p. 277). There was insufficient seed for targets to be achieved and in some places no seeds were available at all. Inadequate account was taken of the types of soil condition necessary for satisfactory beet production. The order to plant beet came late in the season. Many farmers did not know what kind of beet to sow and dared not weed for fear of not recognising the new crop and uprooting it. Transport facilities were often lacking and farmers were stranded with their beet, being unable to carry it to a factory. Often when transport became available and the beet was carted to factories it was found in a decayed state. Yields of sugar from processed beet were low, being about 2 per cent for the Empire as a whole, but somewhat higher in the Nord. The manufacturing side of the operation was mismanaged. In some parts of the Empire there were abundant supplies of beet but no factories, while in

other areas factories could not obtain adequate supplies of beet. Machines were defective almost everywhere and workers were unskilled in the new techniques. Nowhere did the promised results materialise.

Despite these failures, the government maintained its interest in the scheme, especially since successful experiments by M. Delissert had shown that beet-derived sugar could be produced that was virtually identical with that from cane (SÉE, p. 91). Yet hostile public opinion had to be overcome, as French farmers had become wary of growing sugar beet after unsatisfactory initial results. On 15 January 1812, a decree went out to open five more Imperial sugar factories, to create 500 private factories and to plant 100,000 ha. of beet throughout the Empire for sugar production. Again, the scheme was far from successful. In fact, only 334 concessions were granted by the factories and a mere 158 actually operated. Only 1.1 million kg. of sugar were produced by contrast with the expected 3.5 million kg. Even where the industry was already established little encouragement was given to further its growth. Thus the prefect of the Nord had tried to ensure that one of the new Imperial factories should be cited at Lille but he met with no success (DE WARENGHIEN, p. 399).

In the Nord there was limited expansion in beet production in 1812 and the number of factories functioning in the *département* increased to six. Licenses were granted for others to be opened at Dunkirk and Cambrai but these failed to materialise because of a shortage of capital and entrepreneurs' fears of being unable to obtain the necessary quantities of beet for viable operation (LENTACKER [1954], p. 326). With regard to areas sown in 1812, some 4,000 ha. (4 per cent) of the anticipated area in the Empire to be planted with beet for sugar extraction were to be accounted for by the Nord, with the State aiding the operation by financing the provision of suitable seeds (DE WARENGHIEN, p. 423). Such an area was not sown and in 1812 only 1808 ha. were devoted to beet in the Nord, representing an increase of 480 per cent over the area sown in 1811 (Table 1). The failure to meet the anticipated area was not uniform in the *département*. A detailed inventory by *commune* shows that 787 ha. were planted in Lille *arrondissement* falling only slightly below the anticipated 798 ha. (*A.D.N.*, M. 529[7]).

A variety of factors accounted for the relative lack of success of the crop in other parts of the Nord during 1812. Agriculturally, there was a reluctance on the part of some farmers to abandon traditional forms of cultivation for new and untried crops. It was believed that the cultivated soils were really too poor for beet and that they should be reserved for colza. The difficulty of providing adequate manure in the soil preparation phase also hindered the adoption of beet. Conflict existed between growers and sugar manufacturers over the quality of beet that was supplied for processing. Farmers feared that the necessary transport to take the beet to the factories would not be available. Finally, the fact that 2,000 qx. of special seeds failed to arrive from Germany in time for sowing and that seeds from Utrecht and other parts of central Europe had to be used instead (and with only limited success) did much to dampen the enthusiasm for the cultivation of beet. Unfavourable reports on beet production were received from the sub-prefects of Avesnes and Cambrai *arrondissements*. In Dunkirk *arrondissement* the crop was reported as being grown for virtually the first time. Only in Douai, Lille and Hazebrouck *arrondissements* were reactions more positive (DE WARENGHIEN, pp. 423, 462).

At the end of the Premier Empire, the production of sugar from beet had experienced a slow and difficult start in the *département* of the Nord. However, more success had been achieved than in other parts of France. Certainly the area devoted to the growing of beet in the Nord had expanded, from 377 ha. in 1811 to 7,000ha. in 1814 (CAMIER, p. 62). Nevertheless, the reporter for the *Annuaire du Nord* for 1814 could note that in spite of a start having been made on sugar production, beet remained only of real importance for feeding livestock (*Annuaire du Nord* [1815], p. 202). By contrast, Belgian farmers were using the crop successfully for sugar processing. Their achievement was attributed to higher yields, lower wages paid to farm labourers, cheaper fuel for sugar works and a ready home market for alcohol that was produced as a by-product of sugar beet. In the Nord, the new industry had merely been established and its survival depended on State protection.

Sugar-beet production to 1837

French sugar production from beet during the remainder of the nineteenth century was characterised by two main features. First, the total area devoted to beet growing for sugar and the quantity of sugar actually refined were conditioned by complex and changing tariffs which alternately hindered and aided domestic sugar producers. Second, beet production and refining underwent spatial reorganisation to become increasingly concentrated in a small number of *départements* in northern France.

In 1814 a levy of 60 *francs* was imposed on every quintal of foreign sugar imported into the country, while the earlier levy of 40 *francs* per quintal remained on imports of colonial sugar (CAMIER, p. 62). The military defeats of 1814 and 1815 led to the failure of domestic sugar factories as allied forces entered France, resulting both from physical destruction and from the economic implications of the surrender of France. Sée has noted that no beet sugar works managed to survive the Napoleonic period (DE WARENGHIEN, p. 581; SÉE, p. 91). The sugar planters

of the French West Indies were in great financial distress in 1815, crushed by debts following the impact of occupation by the British and of the trade blockade. The French government of the Restoration attempted to revive the old colonial system whereby the French islands sent all their cane to France and bought all their supplies in the mother country (DUNHAM, p. 373). Thus, when peace came and the blockade lifted, cane-sugar prices, which had run up to 3 or 4 *francs* per *livre*, fell back to 80 *centimes* per *livre*. The domestic sugar industry suffered an eclipse and many producers were ruined. In northern France, this period of decline did not last long and in the *département* of the Nord, new factories were soon being built, following the re-opening of M. Crespel's sugar works at Lille in 1817.

The 1820s and 1830s represented a period of struggle between imported cane-sugar and domestical-

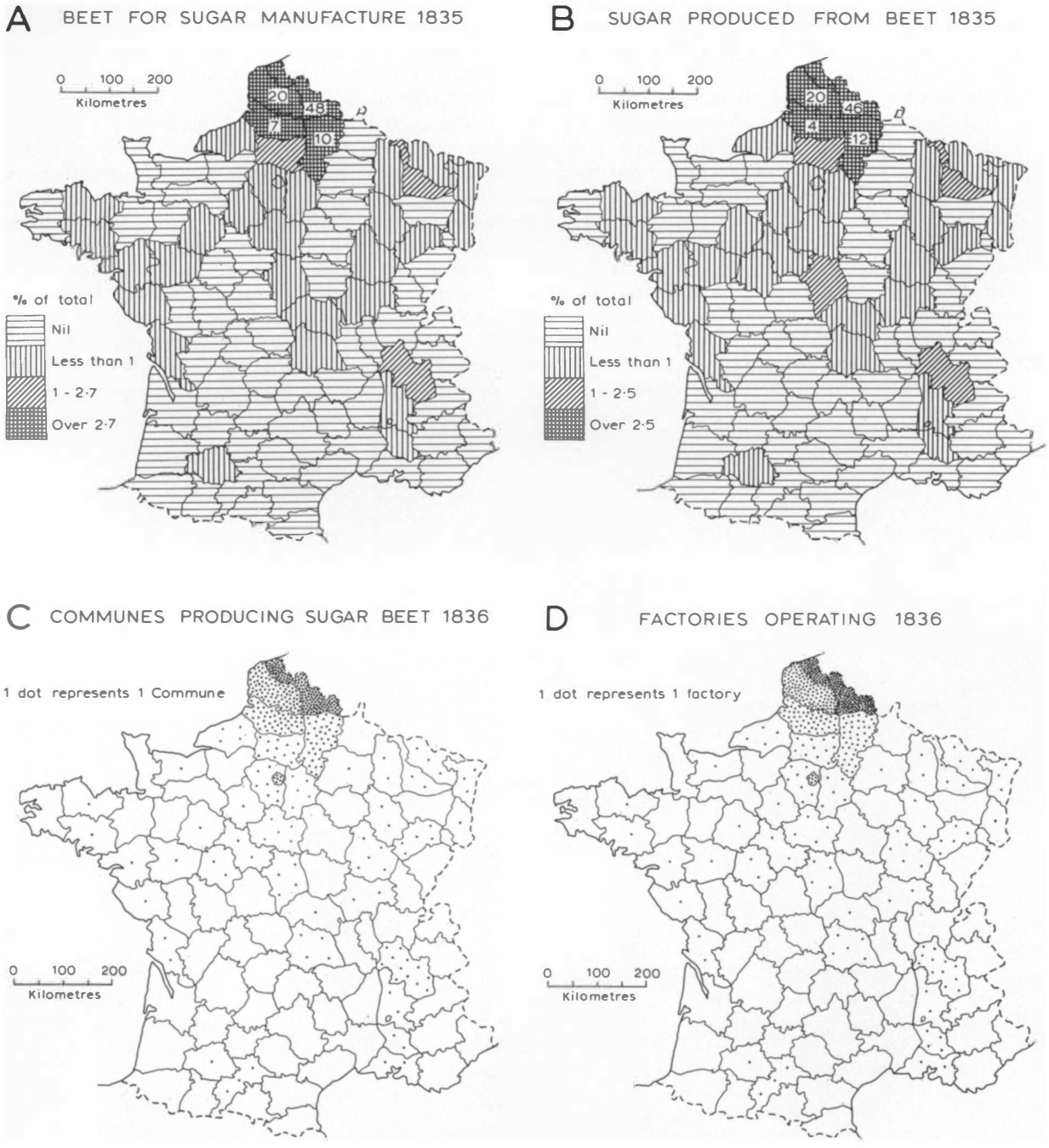

Figure 1: Sugar production from beet in France, 1835/36

ly produced beet-sugar. At the same time, these two decades were marked by a rise in production of beet-sugar in France. The detailed results of the 1835/6 Agricultural Enquiry allows the pattern of domestic sugar production and the extent of recovery from the period of 1814 to be depicted for the whole of the country (*Archives Statistiques* . . ., p. 305). The predominance of northern France in beet production for sugar is clearly established (Figure 1). Farmers in 322 *communes* in the four northern *départements* of the Nord, Pas-de-Calais, Aisne and Somme grew 84.8 per cent of all the beet by area in France that was sent for sugar extraction. The same four *départements* produced 81.6 per cent of all crude domestic sugar. 438 of the 542 factories that operated in the whole of France in 1835 were found in these four northern *départements*. By virtue of the high proportion of weight loss involved in refining, the distribution of factories provides a faithful representation of areas where beet was grown for sugar processing. Of the four northernmost *départements*, the Nord was the unrivalled leader in all aspects of production. Beyond northern France, only tiny quantities of beet-sugar were extracted, often with merely a few *communes* per *département* being involved.

In the *département* of the Nord 322.46 million kg. of beet were produced in 151 *communes* in 1835 and were processed to yield 14.09 million kg. of crude sugar. In the following year 436.23 million kg. of beet were refined to yield 21.17 million kg. The statistics for Douai *arrondissement* have not survived but the remaining material reveals that beet growing for sugar was largely absent from the higher parts of the Avesnois and from the middle plain of Flanders (Figure 2). It was however developed strongly in the *arrondissements* of Lille and Valenciennes (Table 1), concentrating on the centres of activity established in the period 1811–13. In spite of this, significant progress had been made in the *arrondissements* of Avesnes and Cambrai.

The distribution of domestic sugar works reiterates the pattern of beet production to be found in the Nord. In 1835, 212 sugar works were in operation and 14 were reported to be under construction. In the following year 224 factories operated (Figure 2). They were concentrated in the *arrondissements* of Valenciennes and Lille with 72 and 68 respectively (*Annuaire du Nord* [1837], pp. 363–66). The growing importance of beet production in the Nord during the 1830s is revealed by the increasing number of sugar factories in the *département*. In 1828 there had been only 11 and the Nord was in second position to

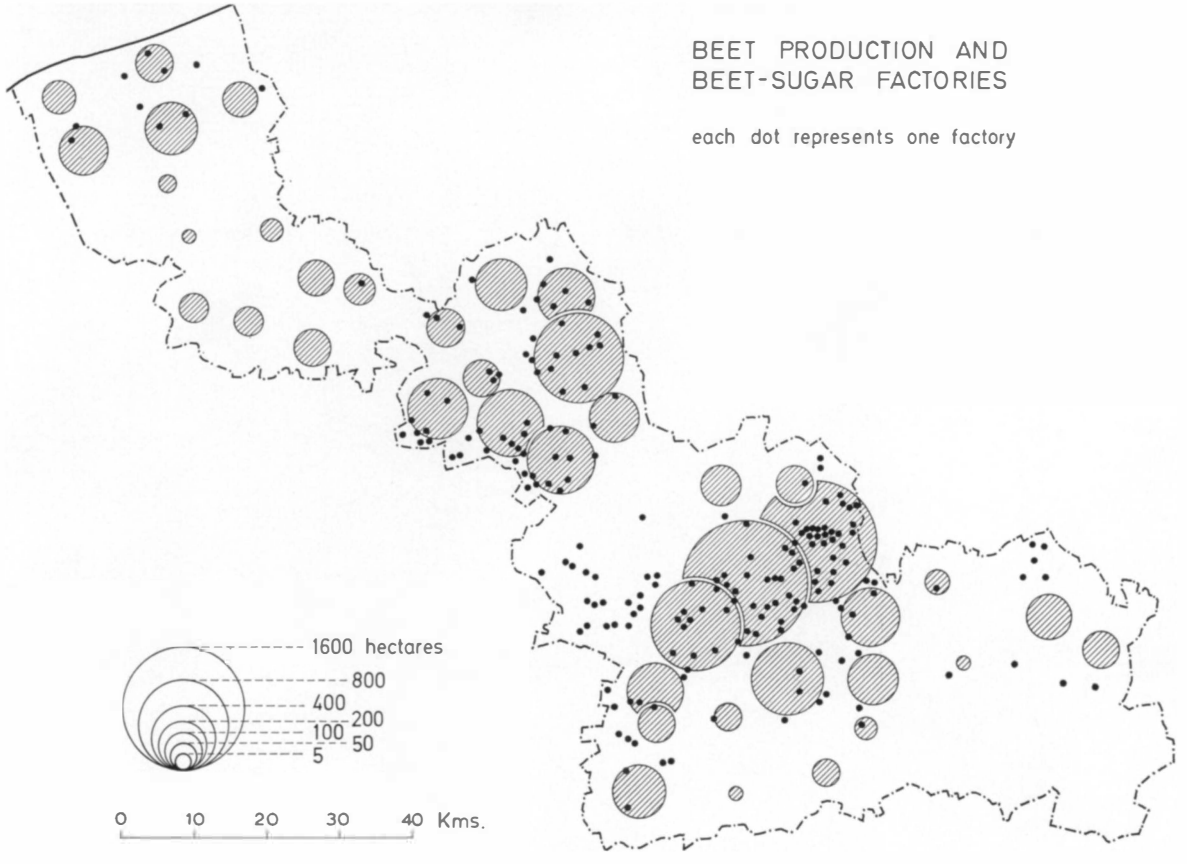

Figure 2: Beet production by *canton* and beet-sugar factories in the Nord, 1836

the Pas-de-Calais (Table 2). But in 1837 there were 226 in operation and the Nord was the unquestioned leader (Figure 3). But many of the sugar factories were very small in terms of both production and employment, and the *Inspecteurs de l'Agriculture* reported that many sugar factories in the Nord were linked to individual farms (*Question des sucres*, p. 228; *Inspecteurs de l'Agriculture*, p. 125). This fact would help to explain the large number of enterprises which operated at this time. Colman confirmed the point. He noted with reference to sugar beet '. . . the greatest profits are realised when an individual unites in himself the character of cultivator and manufacturer. The pulp that remains after the sugar is expressed is employed in the fattening of cattle and sheep' (COLMAN, pp. 168–74). He quoted the opinion of one farmer who estimated that the pulp used for feeding stock represented 35 per cent of the whole value of the crop. Whatever the size of individual factories, beet production had become firmly established by 1836 in the Nord, when it was the leading *département* in France in this respect.

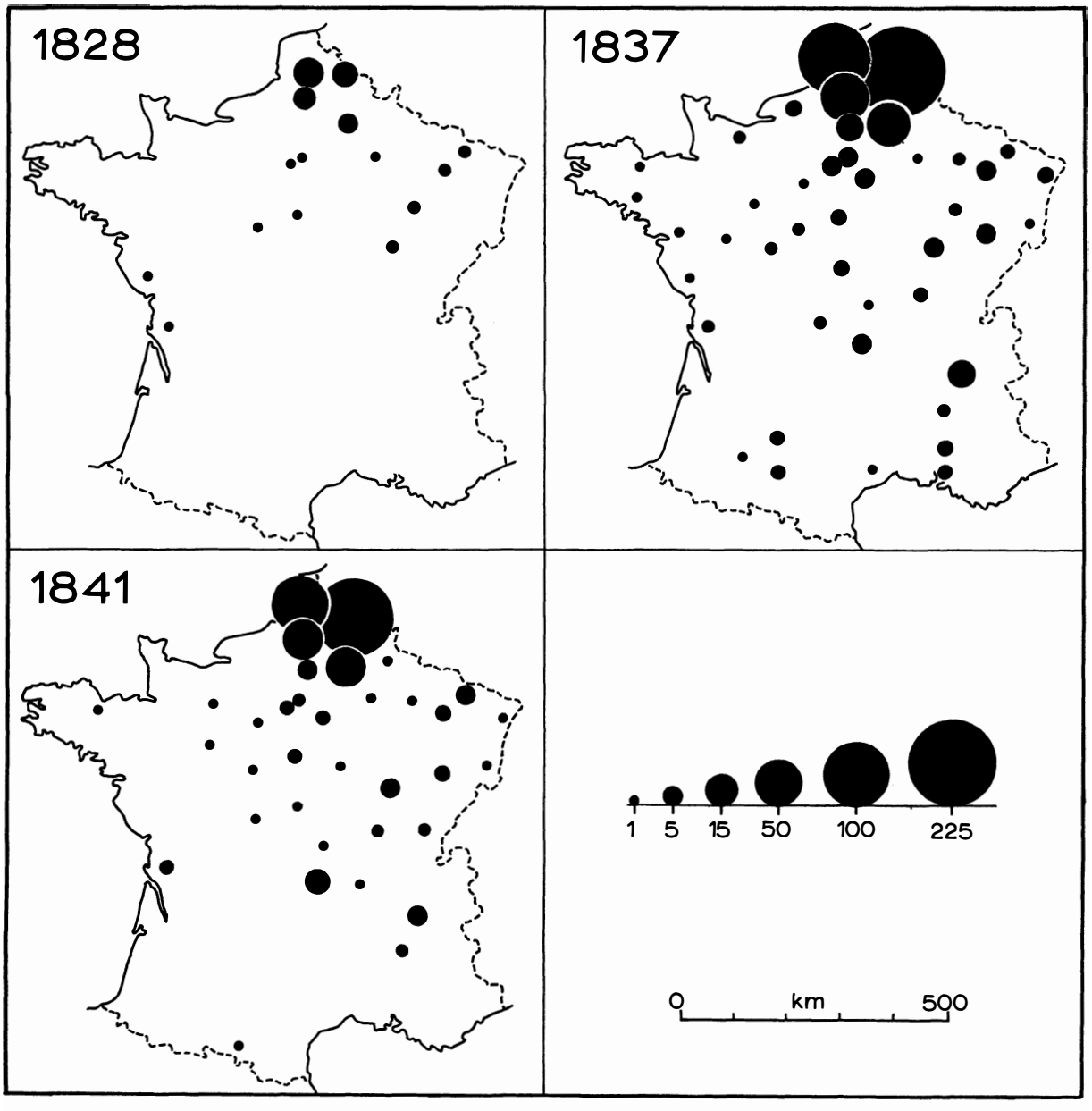

Figure 3: Beet-sugar factories in France by *département*, 1828, 1837 and 1841

Table 2: Beet sugar works in France by département, 1828–1875

1828		1837		1841		1875	
Pas-de-Calais	16	Nord	226	Nord	160	Nord	166
Nord	11	Pas-de-Calais	138	Pas-de-Calais	81	Pas-de-Calais	98
Somme	10	Somme	51	Somme	38	Aisne	91
Aisne	6	Aisne	44	Aisne	38	Somme	67
Côte-d'Or	2	Oise	12	Oise	7	Oise	40
Haute-Marne	2	Seine-et-Oise	7	Moselle	6	Seine-et-Marne	15
Meurthe	2	Seine	6	Côte-d'Or	6	Ardennes	12
Moselle	2	Seine-et-Marne	5	Isère	5	Seine-et-Oise	9
Total	51		489		341		498
National Total	58		585		398		537
Départements with works	15		43		35		25

Sources: '*Question des sucres*', Memoires de la Société d'Agriculture, Sciences et Arts de l'Arrondissement de Valenciennes 4, (1842), 228; '*Industrie du sucre indigène en France*', Revue Agricole, Industrielle et Littéraire du Nord 29, (1876), 110–12.

Sugar-beet production to 1883

In 1837 a new period began in the French beet-sugar industry which was to last until 1883. Levies were calculated on the quantity of beet-sugar actually produced and legislation in 1837 and 1839 introduced a phase of increased taxation on domestic sugar and a reduction of levies on colonial cane sugar. Initial reactions from beet-sugar producers were hostile but they adapted to the situation. While the area of sugar beet increased, a rationalisation in the number of factories occurred. Thus in 1840, 57,663 ha. in the whole of France were devoted to beet for sugar refining (*Statistique . . . de 1862*, p. XXV). On the other hand, the total number of factories increased rapidly from 58 in 1828 (producing 6.5 million kg. of crude sugar) to a peak of 585 in 1837 (producing 40.0 million kg.). There was a marked decline after that date when the real impact of the new levies was experienced and only 398 works operated in 1841 (Table 2). Many of the sugar works, which had functioned in the preceding decade were miniscule in size, having been experimental ventures rather than enterprises operating on a serious economic basis, a fact which was rapidly demonstrated by the impact of the new levies (Dearngeon, p. 232). Furthermore there was a rationalisation in the spatial distribution of the industry and during the early 1840s the beet-sugar industry deserted southern, central and western France to become concentrated in the *départements* of the Nord and the Pas-de-Calais (Figure 3).

This trend was found in the Nord involving an expansion in the area devoted to beet but a reduction in the number of sugar factories, in reflection of changing tariffs and levies. It may be postulated that

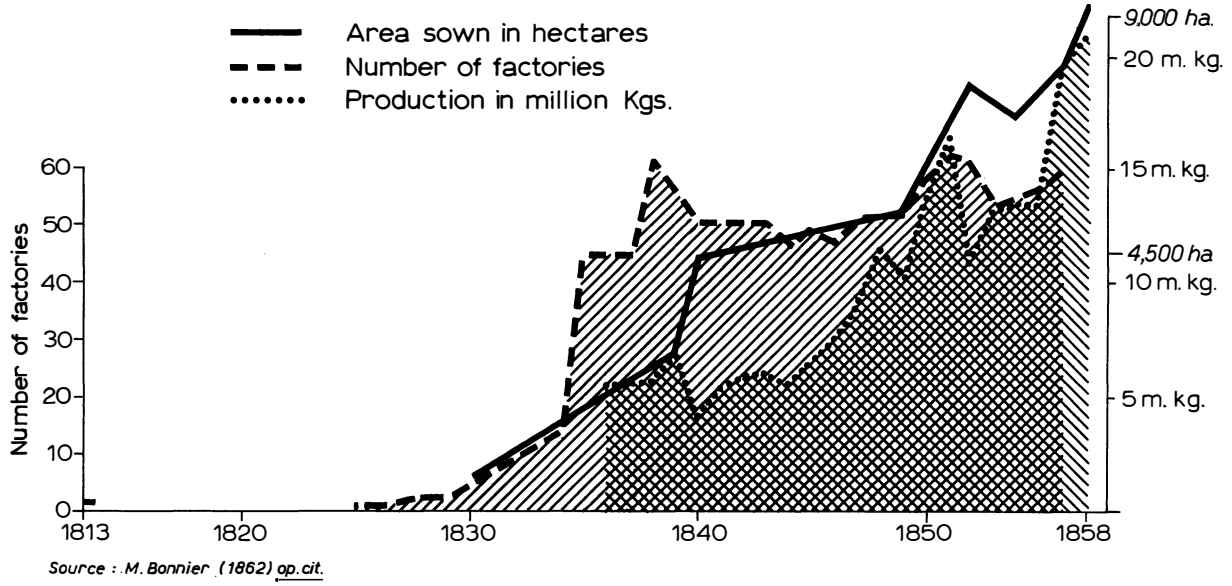

Figure 4: Beet production and sugar factories in Valenciennes *arrondissement*, 1813–58

a large number of beet sugar works would be established in the period of increasing popularity during the early 1830s when tariffs favoured the production of domestic sugar but that because of their small size and of changes in taxation, many of these would not prove viable after more than a few seasons' activity. Thus in the Nord the number of sugar works fell from 226 in 1837 to 144 in 1845 and remained around the latter number until 1875 (Figure 5).

This pattern of change can be detected on a detailed scale in Valenciennes *arrondissement*. After 1814 the area lacked a factory for processing beet (Figure 4). In 1825 a new one was opened and thereafter the number of works grew slowly until 1835 when the number jumped from 15 to 45 in a single year. A peak of 62 was reached in 1839 but the number levelled off to between 50 and 60 in the following 15 years. At the same time, the area devoted to beet rose irregularly from 600 ha. in 1830 to 9,000 ha. in 1857. Beet production also rose from 6 million kg. in 1836 to 22 million kg. in 1856 but with great fluctuations in individual years (BONNIER, pp. 106–12).

The *statistique industrielle* for 1845 confirms the distributional pattern of sugar works in the Nord which had been recognised a decade earlier, and adds valuable information on the structure of the sugar industry at the middle of the century, detailing the number of workers employed, average wage rates, the quantity of beet used and the various by-products derived in the sugar-refining process. Almost 10,000 were involved in the operation of sugar works which treated 305 million kg. of beet and produced 15 million kg. of sugar, giving an average yield of 4.9 per cent. In addition, over 62 million kg. of residue was produced for feeding livestock, together with 2.4 million kg. of bone black *(noir animal)*, 146717 hl of oil and 3.7 million kg. of molasses. It is not possible to plot the distribution of sugar works in detail but they were particularly numerous around Lille, Douai and Valenciennes. Of the 144 in operation some 71 per cent were located in the two *arrondissements* of Valenciennes and Lille and the same areas together accounted for 74 per cent of all workers in the *département's* beet-sugar factories. They handled 76 per cent of the total beet used and produced a similar proportion of the total refined sugar. Beet processing was poorly represented in the *arrondissements* of Avesnes and Dunkirk and was totally absent from Hazebrouck at the time of the industrial enquiry. The report for Valenciennes added the interesting point that the labour force of the sugar works was '. . . employed for only two, three, four or five months of the year; the rest of the time it returns to cultivating the soil' *(Annuaire du Nord* [1846], pp. 379–85; LENTACKER [1961], p. 107).

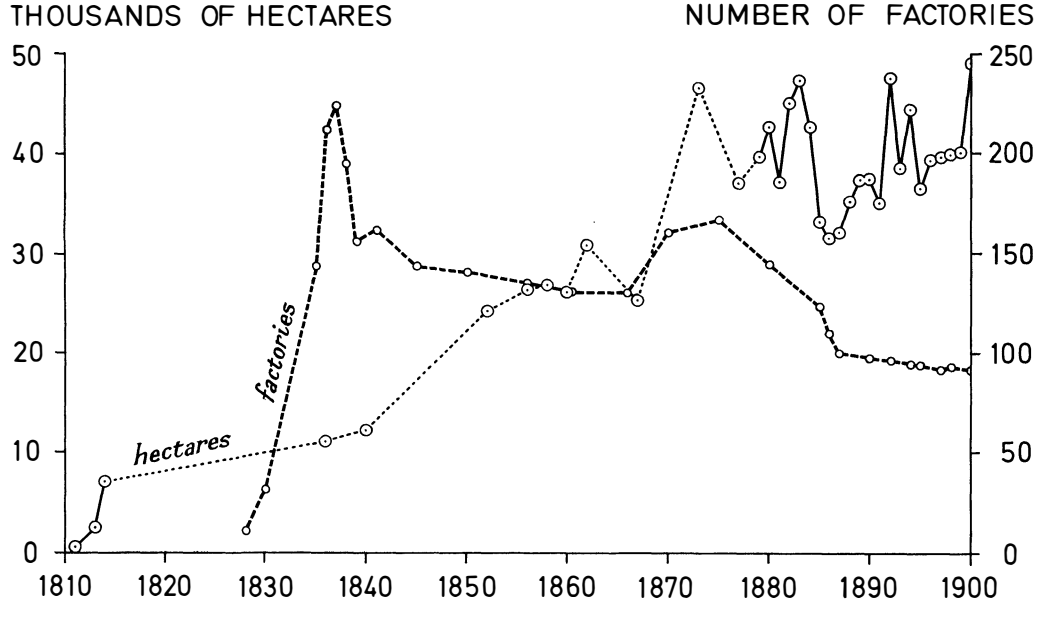

Figure 5: Beet production, 1811–1900 and beet-sugar factories, 1828–1900 in the Nord

Much of the progress in production resulted from the fact that processing techniques to extract more sugar from a given quantity of beet continued to improve in the middle years of the nineteenth century. Thus the yield of sugar in Valenciennes *arrondissement* from a given quantity of raw beet was estimated to have doubled between 1835 and 1848 (BONNIER, p. 109). Biological progress was achieved in the *département* by Louis de Vilmorin who developed in 1856 the first improved beet essentially for sugar production, rather than primarily for providing fodder. His successes were followed by the practical work of Florimond Desprez in the Pévèle district of central Nord. Even greater progress in the development of improved strains of beet for sugar extraction was to come in the two closing decades of the century when the industry had to undergo fundamental modifications to survive competition from German producers of beet-sugar (CAMIER, p. 64; VEZIN and VANDAMME, p. 97).

The French beet-sugar industry won its long struggle over imports of colonial cane sugar, its victory being strengthened by the abolition of slavery in all its territories, including the sugar islands, by the Second French Republic in 1848. The area of the Nord devoted to growing beet for sugar increased throughout the period 1837 to 1884. In 1852 it was reported that the cultivation of beet for sugar extraction was increasing rapidly in the *département* and that by virtue of the importance of its by-products and the large amounts of labour it employed (both in the fields and in the sugar works), it was destined to become one of the leading agricultural activities in the Nord *(A.D.N.*, M. 649[1]). At that time 24,436 ha. in the *département* were devoted to the production of two types of beet, namely the white sugar beet *(betterave de Silesie)* which grew almost entirely underground and the *betterave champêtre*, which was more important for stock feed than for sugar extraction. It is not possible to trace the details of beet production on an annual basis until 1885 but the scatter of figures available for the middle years of the century (Figure 5) would suggest that an increasing proportion of the Nord was being devoted to beet, to reach 46,445 ha. in 1873 when the *département* contained the second largest area under beet in France (Table 3).

The distribution of beet production in the *département* in the third quarter of the nineteenth century maintained the pattern that had been established in earlier periods. Figure 6, derived from the *canton* land use returns for 1857 (sugar beet only) and 1876 (sugar and fodder beet), shows that sections of the Houtland and the Avesnois scarcely produced any beet *(A.D.N.*, M 650[14]). By contrast, *cantons* between Lille and Le Cateau, covering the southern section of French Flanders and parts of the Cambrésis, devoted large areas of land to this crop, with a record 2,855 ha. of sugar beet being recoded in the *canton* of Valenciennes-Ouest in 1857.

The successful growing of beet for sugar production demanded the combination of a number of physical and cultural factors. During the early years of the century, beet production in the Nord was accomplished with varying degrees of success in areas where its sowing had been ordered by the administration, namely close to experimental sugar factories which had been located for reasons other than those stemming from the immediate rationale of beet cultivation. In general terms, the damp climatic conditions of northern France were well suited to the crop. Successful beet production also needed stone-free soil and this condition was well satisfied by the *limons* of Picardy and its surrounding regions. DEMANGEON emphasised that '... sugar beet production is particularly prosperous in areas where the *limon* is thickest and most unform. The disappearance of sugar beet as soon as one moves on to areas of clay with flints strikes even the most casual observer: by contrast, as soon as the *limon* reappears, so the sugar beet returns ...' (DEMANGEON, p. 230).

But the relationship between sugar-beet production and *limon* must not be overstated. *Limon* soils with

Table 3: Sugar-beet production in France, 1873

Département	Area (ha)	Yield qx/ha 1873	Average year	Total product million qx 1873	Average year
Aisne	55607	284	293	15.792	16.292
Nord	46445	299	484	13.887	22.479
Pas-de-Calais	37583	335	360	12.590	13.529
Oise	27484	301	307	8.272	8.437
Somme	25499	320	340	8.159	8.669
Seine-et-Marne	13767	309	217	4.254	2.987
Seine-et-Oise	9614	360	366	3.461	3.518
Ardennes	6568	283	279	1.871	1.772
Others	30818	—	—	9.148	9.392
National Total	253385	306 (av.)	344 (av.)	77.434	87.075

Source: Statistique Internationale de l'Agriculture, 1873 (Paris, 1876), 47–49.

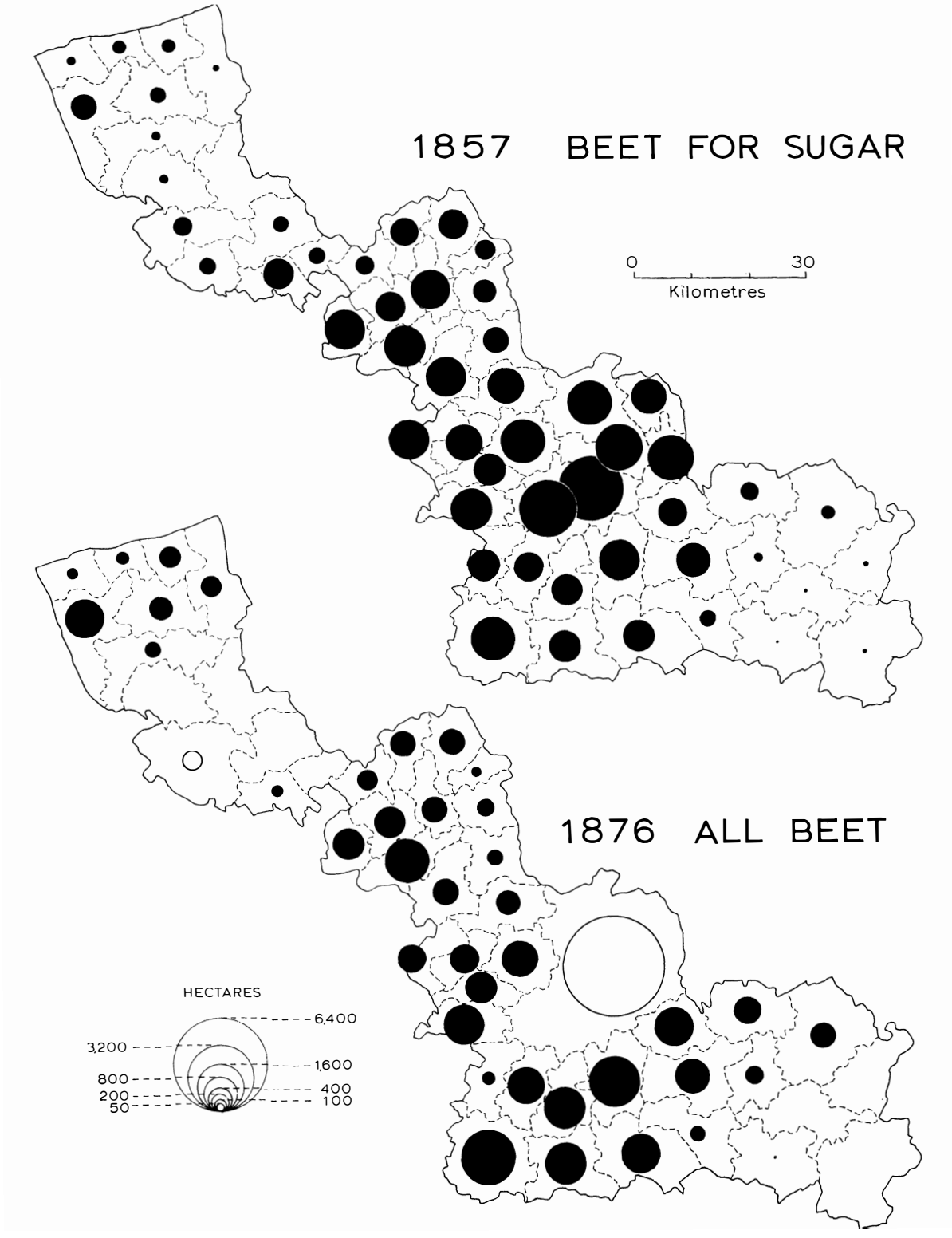

Figure 6: Beet production in the Nord by *canton* 1857 and 1876
(Open circles contain information for more than one *canton)*

an excessive content of sand or chalk would require the application of too much costly fertilizer for viable beet production. Also those soils with an excessively clayey composition would not allow an adequate penetration of air (CAMIER, p. 59). *Limon* was not essential for growing sugar beet in the Nord: in 1857 and 1876 areas devoted to sugar beet were found in regions lacking *limon* (as in Valenciennes *arrondissement),* whilst there was little sugar beet grown in parts of the Avesnois which contained *limon.* Soils of suitable composition were not lacking from other parts of central and southern France but these areas did not produce sugar beet in any quantities. Other factors apart from physical conditions need to be investigated to account for the spatial pattern of sugar-beet production.

Land for sugar-beet production required intensive fertilization and careful weeding. Large inputs of

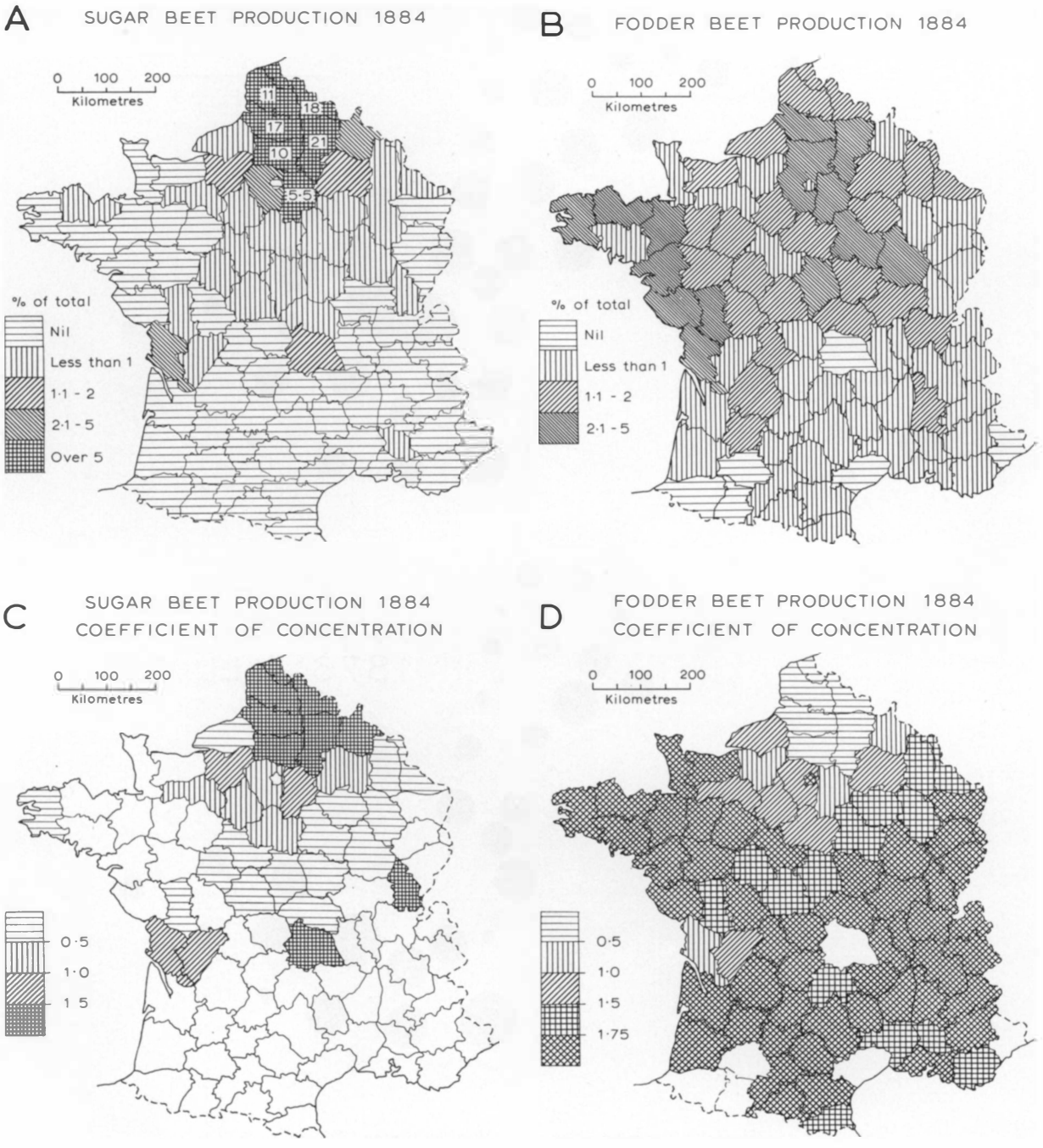

Figure 7: Production of sugar and fodder beet in France by *département,* 1884

labour and capital were required. In addition, good transport conditions by road or water were needed to move the crop to refineries and allow these works to receive adequate supplies of fuel. Agricultural systems needed to be flexible to accommodate the crop, responsive to innovations and sufficiently intensive to afford the necessary labour input. All these conditions were satisfied in the Nord and surrounding *départements* where farmers accepted beet into their rotations as they realised the many advantages to be derived from its cultivation. These had already been enumerated by Chaptal: the growing of beet allowed farmers to insert a harvest between clearing artificial meadows in winter and sowing wheat in autumn. This activity improved the land and was valuable preparation for cereal plants. In general the wheat harvest was one-eighth higher in lands where beet was sown. The beet residue provided excellent cattle feed. The extraction of sugar occurred during winter and supplied work during that season. 'Further cultivation of this crop would greatly increase the proportion of the national income derived from agriculture' (CHAPTAL, pp. 156–61).

Sugar-beet production to the end of the century

The trend of rising production and spatial adjustment which had continued since the late 1830s was broken by new levies which were introduced in the 1880s. In order to make French beet-sugar compete with foreign produced sugar, legislation was introduced in 1884 and 1887 which removed levies from refinend beet-sugar but instead placed them on the quantity of raw beet used in the process (CAMIER, p. 64). Such changes in tariff structure threw French producers into direct competition with German refiners who used far more sophisticated processing techniques. At first French sugar works attempted to employ their normal number of workers but paid them reduced wages (*A.D.N.*, M. 500[6]). Such a situation did not last long and radical changes resulted.

Statistics for 1884 permit the depiction of sugar-beet production before the changes consequent on the new levy began to be effected (*Ministère de l'Agriculture*, pp. 24–29). At a national level, sugar-beet production was still concentrated in Picardy (Figure 7), but the four leading *départements* which had been recognised in the 1830s produced only 67.5 per cent of all sugar beet in 1884 by comparison with 85.0 per cent half a century earlier. The *département* of the Nord produced only 18.3 per cent of all sugar beet and had fallen to second position after the Aisne (21.3 per cent). In fact, only 233 878 ha. (46 per cent) of the 508 421 ha. devoted to all types of beet production in France yielded beet for sugar refining. The remainder produced fodder beet for livestock. Production of this type of beet showed a far wider distribution throughout the country, with important focii in western and eastern France, which did not produce sugar beet. This spatial contrast is brought out by the calculation of coefficients of concentration for both types of beet (Figure 7). High sugar-beet coefficients were found in *départements* located north of Paris. By contrast, high fodder-beet coefficients characterised most other parts of France where beet was either not produced for sugar or only very small proportions were destined for that purpose.

In the second half of the 1880s the intensity of sugar-beet production declined (DEMANGEON, p. 233). Sugar works in northern France closed down and the total area devoted to sugar beet decreased. French sugar refiners reacted to this situation by improving their processing techniques. For example, the 'diffusion' process was adopted that was already used widely in Germany. 'Diffusion' permitted yields of 70–90 kg. of sugar to be obtained from each ton of beet by comparison with only 50 kg. derived by the 'press' technique in use in France. Previously, French beet growers had been more concerned with the output weight of beet per ha. than with its sugar content. Faced with severe German competition French farmers began adopting new, improved beet strains which demanded deep, well-fertilized and stoneless soils. In order to build up gradually to such high standards, French producers in the late 1880s persevered with medium quality strains but intensified their ploughing and fertilizing year by year (reducing inputs of nitrogeneous fertilizers and increasing those of phosphates) so that the very highest quality beet might be produced in the 1890s.

The beet sugar industry in the Nord did not suffer greatly in the period after 1884, although some decline is evident. Thus the number of factories decreased between 1885 and 1900 (Figure 5). The area devoted to sugar beet fluctuated wildly after 1884 and in Cambrai *arrondissement* it fell from over 12,000 ha. in 1885 to 8,000 ha. in 1887 but recovered rapidly to remain at about 15,000 ha. throughout the 1890s (Figure 8). The average annual area sown with beet in the *département* between 1884 and 1900 was 39,000 ha., which was only slightly less than the areas being sown immediately before 1884.

Within the Nord sugar-beet production became increasingly concentrated in areas of 'clayey *limon*' in the *arrondissement* of Cambrai and declined rapidly in the industrialising *arrondissement* of Lille during the 1890s (Figure 8). In 1840 only 11 per cent of the Nord's sugar beet area had been located in Cambrai *arrondissement* but by 1855 this had risen to 29 per cent and was to reach 41 per cent by the end of the century (CAMIER, p. 64). Soils and other physical conditions in the Cambrésis were well suited to the crop and responded well to intensive management during the 1880s and 1890s. Nevertheless, production in Cambrai *arrondissement* had been relatively unimportant earlier in the century when beet growing was concentrated around Lille, Douai and Valenciennes. The rapid industrialisation of coalfield and textile

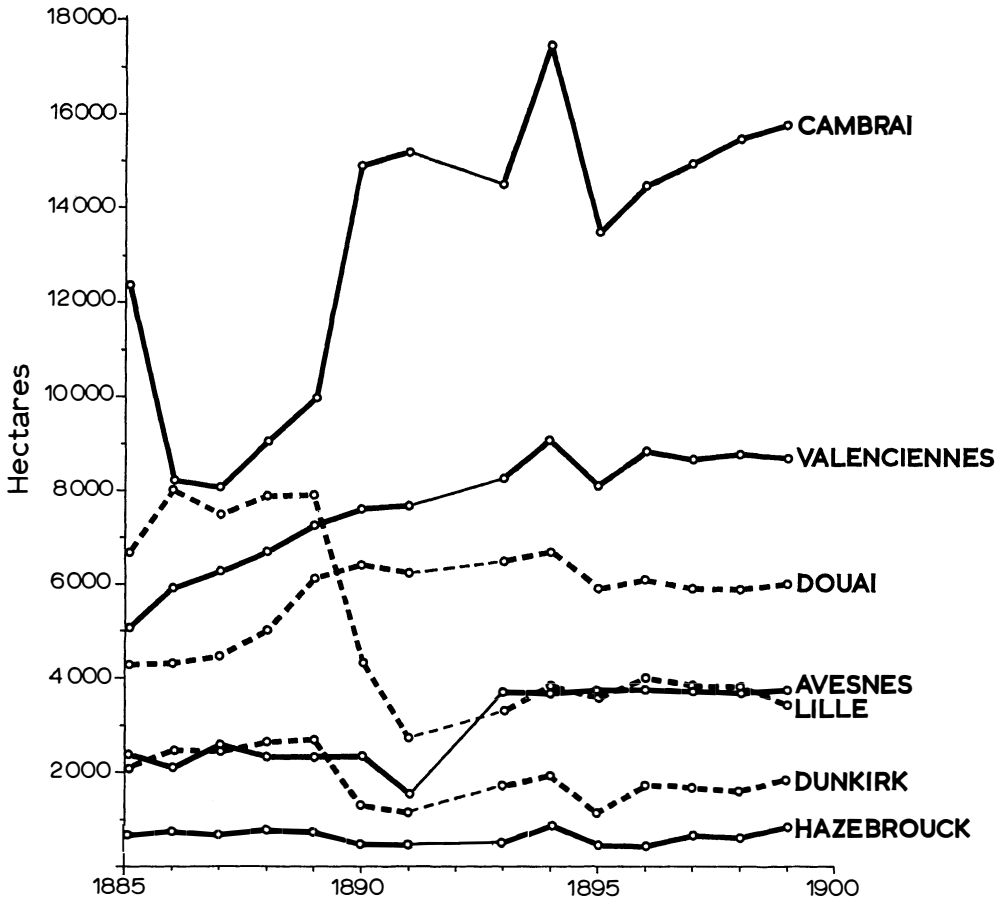

Figure 8: Area devoted to sugar beet in the Nord by *arrondissement*, 1885–1900

towns in Lille and Valenciennes *arrondissement* close to the Belgian border during the final quarter of the century removed the local agricultural labour force that was necessary for successful beet production. This was not the case in the Cambrésis where a binary artisan/agriculturalist situation continued to operate. Indeed the miserable state of many weavers after the 1870s turned them back to agricultural work. Thus, unlike other parts of the *département*, the south-western section of the Nord contained an under-employed and hence cheap labour force in the final quarter of the nineteenth century which was of crucial importance in the intensification of sugar-beet production in Cambrai *arrondissement* during the 1890s. In addition to containing favourable physical and cultural factors for the concentration of beet production, the Cambrésis developed its own processing infrastructure, involving not only the refineries but also canals and narrow-gauge railway lines *(tortillards)* which facilitated the transportation of beet from the fields to the sugar works and provision of coal to fuel the refineries.

By the end of the nineteenth century the growing of beet for sugar processing in the Nord had become increasingly 'industrial' in character. DEMANGEON remarked that the cultivation of this crop had '... become the slave of the laws which control industry; depending on means of transport, fuel resources, and the viability of markets' (DEMANGEON, p. 232). This situation is illustrated by the fact that whilst the *département* of the Nord devoted a smaller surface (47 903 ha.) to sugar beet than the Aisne (61 429 ha.) in 1892, the total output of refined sugar and molasses from the former was greater (Table 4) *(Statistique ... de 1892,* p. 184). By entering increasingly into the already complex rotations of the Nord (to a certain extent as a replacement crop for cereals in the last quarter of the century) beet cultivation had opened the way for 'a real agricultural revolution'. Deep ploughing and intensive fertilization improved the soil so that the yields of crops which followed beet might even double. In financial terms the net return from one hectare of sugar beet (250 *francs*) was estimated to be more than double that derived from wheat (100 *francs)* or oats (120 *francs).* Observers in the early years of the twentieth century agreed that the agricultural wealth of the Nord at that time was largely the result of sugar-beet production as part of

Table 4: Sugar-beet production in France, 1892

Département	Area (ha)	Factories	Weight of beet processed (million kg.)	Sugar + molasses (million kg.)	Refined sugar (million kg.)	Yield in sugar (%)
Aisne	61429	79	1220.847	108.971	102.765	8.42
Nord	47903	91	1220.704	114.197	105.603	8.65
Pas-de-Calais	37325	49	605.402	55.424	51.424	8.49
Somme	35096	59	904.684	83.958	79.625	8.80
Oise	24828	33	466.818	41.858	39.741	8.51
Seine-et-Marne	16278	13	316.204	29.195	27.641	8.74
Seine-et-Oise	9992	9	131.810	11.661	10.991	8.34
Ardennes	5212	8	115.304	10.746	10.207	8.85
Others	33195	27	486.115	44.923	42.555	8.75
National Total	271258	368	5467.888	500.933	470.552	8.60

Source: Statistique Agricole de la France, 1892 (Paris, 1897), 184.

an intensive farming system in which 'the field was only a mere dependency of the factory' (DEMANGEON, p. 234; BLANCHARD, pp. 299, 361). More recently PERPILLOU has noted '... sugar beet remains the characteristic crop of scientific agriculture at the peak of its technique' (PERPILLOU, p. 107).

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