# *The Agricultural Revolution in Germany 1850-1914*

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The tariff on imported grain, which was first applied in 1879 before the rates of duty were substantially increased in 1885 and 1887, has subsequently become the fundamental theme of the historiography of Imperial German agriculture. Innumerable studies have appeared with explanations for the decision of the late 1870s to abandon free trade in cereals for the protection of domestic producers.[1] The response to the amelioration of the level of duty on imported cereals, which took place with the commercial treaties negotiated with Austria-Hungary and Russia in 1892 and 1894 respectively, has become one of the most researched areas of modern German history.[2] Overall, it might be stated that, through its orientation towards the tariff issue, German agrarian history has come to be characterized by a concentration

[1] See, for example, K. W. HARDACH, *Die Bedeutung wirtschaftlicher Faktoren bei der Wiedereinführung der Eisen- und Getreidezölle in Deutschland 1978*, (Berlin, 1967); H. BÖHME, *Deutschlands Weg zur Grossmacht* (Cologne, 1966), Part III; I. N. LAMBI, *Free Trade and Protection in Germany, 1868-1879*, (Vierteljahrsschrift für Sozial-und Wirtschaftsgeschichte, Supplement No. 44, 1963).

[2] Amongst the most outstanding contributions is H.-J. PUHLE, *Agrarische Interessenpolitik und Preussischer Konservatismus im Wilhelminischen Reich (1893-1914)*, (Hanover, 1966).

upon the areas of agricultural policy-formation and the study of the political representation and expression of agrarian interests.

Emphasis upon the grain-tariff forms the basis for the identification and widespread acceptance of the existence of climacterics in Imperial German agrarian history, which in turn underlie climacterics identified in the broader socio-economic development of that era. The first of these has been located in the 1870s and is derived from the shift to protection against lower-cost producers in Russia and North America. Together with the concurrent adoption of duties on imported iron and steel, the grain-tariff of 1879 is viewed as having cemented an "Alliance of Rye and Iron" that was a key factor in the political and social history of the Bismarckian era. A second climacteric has been located in the 1890s, when the Caprivi government's reduction of the duty on imported grain stimulated the emergence of a separate and anti-industrial agrarian interest, in the form of the Farmers' League (*Bund der Landwirte*) of 1893, and contributed towards the re-establishment of a highly protectionist grain-tariff in 1902.[3] Some historians have gone so far as to view the grain-tariff as a crucial factor that influenced the particular course of German history in the XXth century. According to Hans Rosenberg,

> if one considers for the purpose of historical judgement the fateful long-term irrational-ideological internal and external political effects of agricultural policy up to National Socialism, the shift in 1879 proves with the benefit of hindsight to have been one of the greatest mistaken decisions of German, and therefore of European history in the XIXth century.[4]

In the absence of adequate research on the actual developpent of agriculture in the Imperial era, the grain-tariff has come to be widely accepted as the determinant of that development. In

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[3] See K. D. Barkin, *The Controversy Over German Industrialization 1890-1902*, (Chicago, 1970), *passim*.

[4] H. Rosenberg, *Grosse Depression und Bismarckzeit*, (Berlin 1967), p. 182.

other words, to many historians the grain-tariff denotes German agriculture's ' peculiar adaptation to the tensions and incentives of the world market '.[5] More specifically, the duty levied on imported cereals from 1879 was ' undoubtedly a decisive factor in the maintenance of large farms in eastern Germany ' and it ' Kept up food prices, retarded the shift of manpower to other sectors and impeded the conclusion of commercial treaties '.[6] Directly in respect of agricultural production, the grain-tariff, together with what can only be described as a substitution of economic ideology for analysis, has resulted in a generally negative and rather confusing assessment of the performance of German agriculture from the 1870s.

A number of historians have accepted that substantial, but unsubstantiated, agricultural progress was made after 1879, especially on the larger holdings of eastern Germany. At the same time, such historians emphasize that the progress would been more marked in the absence of the grain-tariff. Milward and Saul, for example, consider that in contrast to France, which also adopted a grain tariff in the late 1870s, ' German agriculture made a real contribution to the growth of the economy ' from the 1870s to 1914, and this was ' one of the decisive differences in the history of Germany and France in that period '. Nevertheless, ' the increases in productivity which took place would certainly have been greater without [the grain-tariff]'. Similarly, to Michael Tracy the tariff ' was not an adverse factor to prevent economic growth ' but ' it certainly did not facilitate it '.[7]

While some historians view the tariff as the factor limiting progress in German agriculture, others deny that agricultural progress occurred and ascribe this to the grain-tariff. Helmut

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[5] H. ROSENBERG, ' The Economic Impact of Imperial Germany: Agricultural Policy ', *Journal of Economic History*, Vol. III, Supplement, 1943, p. 103.

[6] F. LÜTGE, *Deutsche Sozial- und Wirtschaftsgeschichte* (3rd edn., Berlin, 1966), pp. 512-3; M. TRACY, *Agriculture in Western Europe*, (London, 1964), p. 105.

[7] A. MILWARD & S. B. SAUL, *The Development of the Economies of Continental Europe*, (London, 1977), pp. 53, 55; TRACY, *op. cit.*, p. 105.

Böhme, for example, has stated of German agriculture in the later 19th-century that: 'Protected by customs tariff ... the transition to more rational methods of production and adjustments to the demands of the world market could be effectively delayed until a later date'.[8] The same point has been more forcefully made by Hans Rosenberg for whom:

> The tariffs restricted technical progress on large-scale sholdings and rewarded inefficiency. What was achieved was the stabilization of cereals production with a fixed arable area... and the stagnation of yields per hectare. The situation was symptomatic of the predominating decline of entrepreneurial energy on the large holdings; the postponement of the transition to more rational methods of production; [and] the prevention of any real adjustment to the revolutionised world market.[9]

More recently, Professor Kitchen has stated of the later nineteenth-century that 'German agriculture stagnated, and was only able to keep up its level of earnings by means of the protective tariffs of 1879'.[10]

The emphasis that has been placed upon the role of the grain-tariff in agricultural development is somewhat surprising in view of the fact that most studies of its actual effects deny that it exercised a significant influence. As early as 1889, in his study of the first ten years of operation of the tariff, Wilhelm Lexis concluded that it had failed to insulate domestic cereals prices from movements in the world cereals economy. More importantly, it had not raised the domestic price by anything like the amount of the duty. In other words, a substantial proportion of the duty was absorbed by exporters of grain to Germany. At the same time, the grain-surplus districts of eastern Germany faced high transport

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[8] H. Böhme, *An Introduction to the Social and Economic History of Germany*, (Oxford, 1978), p. 79.

[9] Rosenberg, *Grosse Depression*, *op. cit.*, p. 185.

[10] M. Kitchen, *Political Economy of Germany 1815-1914*, (London, 1978), p. 159.

costs for internal comunication with the urban-industrial markets of the west that could be more conveniently supplied by imports.[11] More recently, Gerhard Schildt has shown that the growth of Russian exports of grain to Germany was not impeded by the tariff.[12] Finally, in his sophisticated analysis of the available data, Hans-Georg Reuter has provided convincing support for the earlier view of Lexis.[13]

The only way in which it is possible to surmount the contradictions and the confusion that exist in the historiography of Imperial German agriculture is to eschew ideological commitment to either the doctrines of free trade or protectionism and, more particularly, to analyse and interpret the development of the forces and relations of agricultural production. Viewed from this perspective the outstanding characteristic of Imperial German agricultural development was the intensification of production, which in essence involved increasing inputs of capital and entrepreneurial skill — and also labour in terms of efficiency more than in terms of quantity — to a more or less fixed area of agricultural land.[14] The objective here was to combat falling prices

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[11] W. Lexis, 'Die Wirkung der Getreidezölle', in *Festgabe für Georg Hanssen zum 31. Mai 1889*, (Tübingen, 1889), pp. 211-2, 216, 218. See also. Franz, 'Die Deutsche Landwirtschaft, ihre Notlage und ihre Hülfsmittel', *Landwirtschaftliche Jahrbücher*, Vol. XV, 1886, p. 886. Franz was a supporter of them but he had warned farmers 'not to attach too great expectations to the tariffs'; and he considered himself vindicated by the fact that by 1886 a threefold increase of the duty levied in 1879 had had no recognizable effect on grain prices because of an oversupply of grain in the world market.

[12] G. Schildt, 'Die Auswirkungen der Deutschen Agrarzölle unter Bismarck und Caprivi auf den Russischen Getreideexport', *Jahrbuch für die Geschichte Mittel- und Ostdeutschlands*, Vol. XIV, 1975, pp. 128-142.

[13] H.-G. Reuter, 'Schutzzollpolitik und Zolltarife für Getreide 1880-1900', *Zeitschrift für Agrargeschichte und Agrarsoziologie*, Vol. XXV, No. 2, 1977, pp. 199-213.

[14] See R. Berthold, 'Bemerkungen zu den Wechselbeziehungen zwischen der Industriellen Revolution und der Kapitalistischen Intensivierung der Feldwirtschaft in Deutschland im 19. Jahrhundert', *Jahrbuch für Wirtschaftsgeschichte*, 1972, Part 1, pp. 261-7, esp. pp. 261, 263. A measure of the degree of intensity of farming adopted in the later XIXth-century was the ratio of basic capital (*Grundkapital*) — the value of land and buildings — to operating capital — the value of livestock, deadstock and wages. The lower the ratio of the former to the latter, the more intensive was the farming system

for agricultural commodities by raising output per unit of land, and to maintain returns per unit of output by enhancing the degree of dependence of farming upon capital inputs that embodied technological progress and were experiencing falling real costs through economies of scale in production.[15] Moreover, it was not the grain-tariff that 'saved Germany from reversion to "extensive" methods of arable farming'.[16] Rather it was the virtually inevitable response of German farmers to the conditions of agricultural production in that country and a continuation of a process that commenced well before the 1870s.

The phenomenon of the intensification of agricultural production in Germany originated at least as early as the 1850s, following the virtual completion of the process of emancipation of the peasantry from feudal obligations. It is possible to detect an acceleration of intensification from the 1870s onwards, when European farming began to experience the full impact of competition from lower-cost agricultural producers in Russia and North America; but there was no reversal of the trend or a climacteric in the 1870s. In this respect, the German experience was analogous to the contemporary British one, except in the direction of change. Overall, the response of British agriculture to foreign competition from the 1870s, as a German writer observed in 1910, 'occurred under the banner of the intensification of arable husbandry, the transition to pastoral economy [and] the retreat of cereals cultivation to the best lands.'[17] However, this was merely the continuation of a trend that was evident as early as

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considered to be. (See H. ROTH, *Über den Einfluss des Zuckerrübenbaues auf die Höhe der landwirtschaftlichen Kapitalien besonders im Königreich Sachsen* (Leipzig, 1892), pp. 5-6, 26). The deficiency of this approach, however, is that an increased outlay on operating capital leads — other things being equal — to an increase in the value of basic capital.

[15] See K. BALLOD, 'Die Produktivität der Landwirtschaft', *Schriften des Vereins für Socialpolitik*, Vol. CXXXII, 1910, p. 463.

[16] J. H. CLAPHAM, *Economic Development of France and Germany 1815-1914*, (4th edn., Cambridge, 1961), p. 214.

[17] BALLOD, *op. cit.*, p. 435.

the 1850s.[18] In the later 1860s it was said that ' the tendency of British agriculture is towards a preference of pasturage and root-crops over grain '.[19] Subsequently, from the 1870s, it became a tendency to prefer pasture over both cereals and rootcrops.

Apart from being a continuation of an established trend, the intensification of farming in Germany from the 1870s was to a considerable extent an inevitable and rational response to the conditions of agricultural production in that country. In the overwhelmingly owner-occupying agricultural system of Germany in contrast to Britain where nine-tenths of agricultural land was tenanted, the major costs of extensifying production — the decline of land values and the loss of capital invested in long-term improvements — would have been borne exclusively by the farmers. Moreover, such losses would have been considerable in view of the substantial investment in the intensification of production, and the rise in land values that had taken place from the 1850s. If the German farmer had adopted more extensive farming practices he could perhaps have maintained an operating profit at the expense of a fall in the value of his land and in his net income from a diminished output. On the other hand, by intensifiing production he could possibly maintain the value of his land, and also his net income, by expanding gross output in the face of what was prospectively only a short-term fall in agricultural prices. Understandably, he chose the latter course. From the 1870s onwards, as one writer observed.

> A reversal of the entire system of production to more extensive types of farming would not have been possible on the majority of holdings without the loss of a substantial proportion of the capital invested. It was therefore essential to maintain the level or intensity of production.[20]

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[18] See E. L. JONES, ' The Changing Basis of English Agricultural Prosperity, 1853-1873 ', *Agricultural History Review*, Vol. X, 1962, pp. 102-119.

[19] A. BARUCHSON, *Beetroot Sugar*, (London, 1868), p. 32.

[20] K. BIELEFELDT, *Das Eindringen des Kapitalismus in der Landwirtschaft*, (Berlin, 1911), p. 112.

In most areas of Germany farmers were precluded from extensifying production through the conversion of arable to pasture by soil and climatic conditions. The majority of farmers in the eastern territories were not in a position to fatten cattle or establish dairies on permanent pasture in consequence of the infertility of their land, and in central Germany the rainfall was too small for such activities to be remunerative. Sheep rather than cattle were the typical livestock of extensive farming systems under German conditions. They thrived on poor pasture and the long and intense frost in Germany prevented them from being folded on rootcrops over winter in an intensive-farming system. However the expansion of the sheep numbers was precluded by the considerable fall of wool prices in the later XIXth-century and by the failure of German consumers to acquire a taste for mutton. The national flock actually declined drammatically in size, from 19.2 million in 1883 to 7.7 million by 1907.[21]

The continued intensification of farming in Germany from the 1870s was closely related to the substantial improvements in the techniques and technology that had occurred over previous decades. As a contemporary authority on agricultural machinery observed of the alternative of extensifying production: 'The farmers could only acquiesce with difficulty in such a deterioration of their farming where technical progress had given them the opportunity to improve the volume and quality of their production'.[22] Throughout the period from 1850 to 1914 the

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[21] R. BERTHOLD, 'Zur Entwicklung der deutschen Agrarproduktion und Ernährungswirtschaft zwischen 1907 und 1925', *Jahrbuch für Wirtschaftsgeschichte*, 1974, Part IV, p. 97; W. SOMBART, *Das Wirtschaftsleben im Zeitalter des Hochkapitalismus*, Vol. III, Part 1, (Munich, 1927), p. 248. In a study of 21 farms in Central Germany during the 1900s, the decline of sheep numbers was attributed to 'the contradiction between sheep-farming and intensive agriculture'. (G. JUNSER, *Betriebsverhältnisse der Zuckerrübenwirtschaften im Regierungsbezirk Merseburg* (Arbeiten der Deutschen Landwirtscheft -Gesellschaft, No. 207, Berlin, 1912), p. 68. (See also H. ALVERMANN, *Untersuchungen über die Landwirtschaft des Saalkreises* (Dissertation: University of Halle, 1920), p. 36.

[22] G. FISCHER, 'Die Entwicklungsbedingungen des landwirtschaftlichen Maschinenwesens und seine Bedeutung für die Landwirtschaft', in *Die Entwicklung des land-*

main advances in agricultural techiques and technology were concentrated in the area of intensive arable-farming. The advances in livestock-farming were most pronounced where this activity was integrated with arable in mixed-farming systems. And the the progress made in the latter form of agriculture provided a remunerative market for fattening, dairying and draft livestock, which enabled extensive farming-systems to survive in the marginal agricultural areas that were restricted to pastoral farming by geographical conditions.

## II

The emphasis placed upon the grain-tariff in the historiography of Imperial German agriculture stems from a virtually complete identification of farming with cereals production. Admittedly, throughout the period 1870-1914 grain crops accounted for over half of the arable area and the proportion even increased over time: from 52.6 per cent of arable land in 1878 to 55.3 per cent in 1900.[23] Nevertheless, cereals accounted for considerably less than 50 per cent of the total agricultural area, of which some 48 per cent was devoted to meadow and pasture. The proportion of the arable area cereals occupied probably diminished over the century as a whole with the secular disappearance of the three-field system, of two grain crops to one year of bare fallow, and its replacement by rotations including a wider range of crops.[24] The proportionate increase of the cereals area from the 1870s was considerably less than that of some other categories of crops. And if criteria other than relative cropping areas were adopted it

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*wirtschaftlichen Maschinenwesens in Deutschland*, (Arbeiten der Deutschen Landwirtschafts-Gesellschaft, No. 177, Bonn, 1910), p. 14.

[23] E. GLÄSEL, 'Die Entwicklung der Preise landwirtschaftlicher Produkte während der letzten 50 Jahre und deren Einfluss auf Bodennutzung und Viehhaltung im Deutschen Reiche', *Landwirtshaftliche Jahrbücher*, Vol. L, 1916, p. 558.

[24] W. KELLERMANN, 'Die Steigerung der Roherträge des Ackerlandes in Deutschland seit Anfang des 19. Jahrhunderts', *Landwirtschaftliche Jahrbücher*, Vol. XXXV, 1906, p. 297.

becomes clear that the significance of cereals has been considerably exaggerated.

The really outstanding feature of German agriculture from the 1850s onwards was the considerable expansion of the area devoted to root-crops, and in particular to potatoes and sugar beet. From 1878 to 1900 the proportion of arable occupied by root-crops increased from 13.7 to 17.7 per cent. In absolute terms, between 1878 and 1915 the rootcrop area expanded from 3.55 to 5.10 million hectares. Whereas 13.7 of every 100 hectares of arable land had been devoted to roots in 1878, by 1913 the proportion was 19.7 hectares. By the eve of the First World War Germany was unique in the extent to which its agriculture was oriented towards rootcrop cultivation, with approximately eight times the proportion of arable that was devoted to such crops in England and three times that in France.[25]

Admittedly, even at its peak in 1914 rootcrops occupied only some 40 per cent of the area devoted to cereals. However, in terms of more meaningful quantitative and qualitative measures of importance rootcrops came to more than rival cereals. Physical yields of roots, which largely determined the demand for labour and for capital embodied in machinery for the peak season of harvest, were a multiple of cereals. In the harvest of 1899, for example, the average volume harvested per hectare of sugar-beet, at 26,500 kilogrammes, was some 14 times that of wheat at 1,910 kilogrammes. In the harvest of 1900 under two per cent of the arable area that was devoted to sugar beet yielded 1,364,000 tonnes of beet compared with a total of 2,295,000 tonnes of cereals from over 50 per cent of the arable area. In the same year the potato harvest amounted to over 30 million tonnes. In terms of calories sugar beet in the period 1909/1913 yielded an estimated 23.8 billion per hectare and potatoes 9.6 billion, whereas rye and

[25] GLÄSEL, *op. cit.*; W. RADETZKI, 'Der gegenwärtige Stand der landwirtschaftliche Wanderarbeiterfrage in Deutschland', *Landwirtschaftliche Jahrbücher*, Vol. LXIII, 1926, p. 307; B. BRUKNER, *Zucker und Zuckerrübe im Weltkrieg*, (Berlin, 1916), p. 63.

wheat yielded 5.1 and 6.5 billion respectively.[26] Admittedly, the portion of the rootcrop harvest that was directly consumed by human beings, or processed into sugar, was low in protein and high in carbohydrates when compared to cereals. However, this was partially compensated by the enormous volume of fodder yielded by rootcrops, in the forms of tops from sugar beet and waste from sugarmills and distilleries, that was converted into protein by livestock.

In general it may be said of rootcrops that they formed the basis of the intensification of agricultural production in Germany from the 1850s onwards. That the extent of land under roots formed a measure of intensification is indicated by the contemporary dictum: 'the higher the share of rootcrops in the rotation the more intensive the cultivation'. One writer went so far as to state, in 1911, that 'The great increase of rootcrop cultivation has industrialized agriculture', by considerably increasing its dependence upon capital and labour rather than land. Sugar beet, in particular, has been viewed as 'the leading sector in the capitalist intensification of agriculture' in 19th-century Germany.[27] Roots were not only an important endproduct of farming that came to rival grain crops, they also formed the pivotal crop in sequences and had a profound effect upon the development of agricultural production in its entirety.

The innovation of rootcrop cultivation was closely associated with the transformation of field systems in Germany, from open field and commons that were an obstacle to the remunerative

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[26] T. ROEMER, *Handbuch des Zuckerrübenbaues*, (Berlin, 1927), p. 20; BRUKNER, *op. cit.*, pp. 32–3; A. SKALWEIT, *Die deutsche Kriegsernährungswirtschaft* (Stuttgart, 1927), p. 63.

[27] ROEMER, *op. cit.*, p. 32; HAGMANN, 'Löhne der einheimischen und der Wanderarbeiter in Schlesien und der Rheinprovinz', *Landwirtschaftliche Jahrbücher*, Vol. XL, 1911, p. 670; T. ZELLER, *Der Kampf zwischen Rohr- und Rübenzucker*, (Tagesfragen der Auslandswirtschaft, No. 4, Leipzig, 1920), p. 5; G. B. HAGELBERG, 'Anhaltspunkte zur vergleichenden Wirtschaftsgeschichte von Rohr- und Rübenzucker bis zur Mitte des 20. Jahrhunderts; *Jahrbuch für Wirtschaftsgeschichte*, 1971, Part III, p. 163; R. BERTHOLD, 'Grundprobleme der Sozialökonomischen Entwicklung in der Magdeburger Börde', *Jahrbuch für Volkskunde und Kurturgeschichte*, Vol. XX, 1977, p. 159.

cultivation of roots to enclosed or separated holdings. The growing season for rootcrops differed markedly from that of other major crops cultivated, i.e. cereals, clover and legumes, in that both sowing and harvesting occured later in the year. Hence, under the traditional open-field system, the live-stock of the villages allowed on the fallow field and that of manorial lords with rights to pasture cattle on the villagers' arable from late in summer onwards, would have devastated growing crops of roots. Moreover, the latter when grown on the fallow field would not have been cleared from the land in time to permit autumn-ploughing for the succeeding crop of winter corn. More important, perhaps, rootcrops imposed quite different requirements on the soil from other field crops, which necessitated a restructuring of crop sequences and of the inherited allocation of land between open-field arable and common pasture which had developed solely in response to the requirements of cereals cultivation. As a minimum this involved the consolidation of individuals' strips in the open-field and the division of the commons. Alternatively, root-crop cultivation was most remunerative on enclosed holdings of contiguous fields, and it is no accident that the process of enclosure commenced earliest and was most extensively undertaken in the regions of Germany which pioneered the cultivation of roots as field crops.[28]

On individually-operated holdings the adoption of rootcrop cultivation occasioned a change from relatively inflexible crop sequences designed to maximize yields of cereal crops to actual crop rotation [*Fruchtwechselwirtschaft*] that took account of local

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[28] H. PAASCHE, 'Die jüngste Entwicklung der Zuckerindustrie und die Reform der Zuckersteuer', *Jahrbücher für Nationalönomie und Statistik*, Vol. XLIX, 1887, p. 281; E. VON STREBEL, 'Die einzelne Ackerbaugewächse und deren Kultur' in T. von der GOLTZ (ed.), *Handbuch der gesamten Landwirtschaft*, Vol. 1, *Der Acker- und Pflanzenbau*, (Tübingen, 1889), p. 537; W. STRAUSS, *Die Landwirtschaft der Kreis Neuhaldensleben*, (Dissertation: University of Tübingen, 1920), p. 43; H. THIEL, 'Beschreibung und Ertragsberechnung einer Zuckerrübenwirtschaft', *Landwirtschaftliche Jahrbücher*, Vol. III, 1874, p. 31; BERTHOLD, *Jahrbuch für Volkskunde*, 1977, *op. cit.*, p. 168.

soil and climatic conditions, of the interrelationships of crops and of price movements for a wider range of crops than hitherto. Broadly speaking, by the 1870s the potato had emerged as the basis of rotations on the light and sandy soils of the eastern territories. Of these poor soils it could be said that 'agriculture was to a large extent made possible by the introduction of the potato'.[29] On the fertile loams of central Germany, on the other hand, the place of the potato was taken by sugar beet and elsewhere fodder beet became the pivot of rotations. Within this broad division rotations varied considerably to take account of local and intrafarm differences in conditions.[30]

In central Germany the frequency with which sugar beet appeared in rotations broadly correlated with the fertility of the soil. By the 1860s, however, even the best soils had begun to "tire" of the crop through the build-up of nematodes or eelworms in the soil. In the absence of pesticides, the only means of controlling or eradicating nematodes and other pests was by reducing the frequency and proximity of crops in rotations that were susceptible to particular pests, and by interspersing crops considered to have pesticidal effects. Thus to combat nematodes, crops of sugar beet, and oats that were also susceptible, were grown as far apart as possible in rotations, clover was interspersed as it did not provide an environment in which the pest multiplied, and often a crop of chicory was taken in the belief that it emitted a substance that 'unfavourably influenced the living conditions of nematodes'.

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[29] W. LILIENTHAL, *Die Bedeutung des Hackfruchtbaus namentlich des Zuckerrübenbaus für die Steigerung der Getreide- und Viehproduktion in Deutschland*, (Dissertation: University of Heidelberg, 1895; pub. Jena, 1895), pp. 12-13; E. LANGENBECK, 'Die märkische Brennereiwirtschaften' in *Betriebsverhältnisse der deutschen Landwirtschaft*, Vol. 1, (Arbeiten der Deutschen Landwirtschaft-Gesellschaft, No. 118, Berlin, 1906), p. 163; W. BEHREND, *Deutschlands Kartoffelerzeugung und Verbrauch im Gegenwart und Zukunft*, (Berlin, 1905), p. 30.

[30] SCHMIDT, *Die Entwicklung der Landwirtschaft der Stadt Aschersleben im 19. Jahrhundert unter dem Einfluss des Samenbaues*, (Dissertation: University of Halle, 1910; pub. Halle, 1910), pp. 12-13, 37-8; THIEL, *op. cit.*, p. 30; K. B. BREINLINGER, *Die Landarbeiter in Pommern und Mecklenburg*, (Heidelberg, 1903), p. 102.

Over the long-term, however, 'the army of sugar beet diseases and insect pests' presented 'a challenge to science that led, from the end of the 1870s, to modern plant protection'.[31]

The expansion of rootcrop cultivation in Germany from the 1850s was intimately linked with the origins and subsequent rapid growth of artificial fertilizer consumption, which became an outstanding feature of the agriculture of that country and an integral part of the process of intensification of farming. Until the later 1850s, when local sugar-beet growers began to apply it to their land, the potash of central Germany was considered a waste-product from saltmining operations. Between 1861 and 1870 sales of potash rose from 2,295 to 288,597 tonnes, although the majority was utilized by the chemical industry in the manufacture of potassium chlorate. The real growth of potash mining to produce artificial fertilizer began in the early 1880s after a period of experimentation with the more effective form of Kainit. Between 1880 and 1910 output of potash increased from 668,596 to over 8 million tonnes, and the proportion used in agriculture increased from 42.5 to 96.0 per cent. Whereas only 0.67 kilogrammes of pure potash were applied per hectare of agricultural land in 1889, by 1903 the figure was 4.39 kilogrammes.[32]

From the 1870s the use of nitrates and superphosphate increased rapidly in German agriculture. Imports of Chilean nitrates grew from 50,000 to 484,000 tons between 1878 and 1900. By the early

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[31] A. F. KIEHL, *Sechzigjährige Erlebnisse und Erfahrungen eines alten Rübenbauers*, (2nd end., Berlin 1918), pp. iii, 101-2; *Strebel, op. cit., op. cit.*, p. 533; SCHMIDT, *op. cit.*, pp. 53-4; T. SCHUCHART, *Die volkswirtschaftliche Bedeutung der technischen Entwicklung der deutschen Zuckerindustrie*, (Leipzig, 1908), pp. 218-9; H. Haushofer, *Die deutschen Landwirtschaft im technischen Zeitalter*, (2nd edn., Stuttgart, 1972), p. 232.

[32] G. AUBIN, *Entwicklung und Bedeutung der mitteldeutschen Industrie* (Halberstedt, 1924), p. 18 H. W. Schütt, 'Anfänge der Agrikulturchemie in der ersten Hälfte des 19. Jahrbunderts', *Zeitschrift für Agrargeschichte und Agrarsozialogie*, Vol. XXI, No. 1, 1973, p. 90; K. VAN DELHAES-GUENTHER, *Kali in Deutschland* (Cologne, 1974), pp. 4, 46, 80; M. Eyth, *Tagebücher 1882-1896* (Frankfurt, 1975), p. 136; Schuchart, *op. cit.*, p. 210; A. ZANDER, *Die wirtschaftliche Entwicklung der Provinz Sachsen im 19. Jahrhundert*, (Dissertation: University of Halle, 1934), pp. 99-100, 130; L. HABER, *The Chemical Industry during the Nineteenth Century*, (Oxford, 1958), pp. 49-50, 121, 125.

1890s an alternative source of nitrogen in the form of ammonia sulphate was available as a by-product from coking ovens. From 1895 to 1913 consumption of ammonia sulphate as artificial fertilizer (in terms of pure nitrogen) increased from 16,000 to 95,000 tonnes, and that of Chilean nitrates on the same basis expanded from 50,300 to 74,700 tonnes. Phosphate, the major artificial fertilizer, was also applied in increasing quantities, especially from the 1880s with the appearance of basic slag as an alternative source from the Gilchrist-Thomas process for smelting phosphoric iron ore. From 1905 to 1913 alone consumption of basic slag in German agriculture increased from 1.40 to 2.42 million tonnes and that of imported superphosphate from 0.87 to 1.82 million tonnes.[33]

TABLE I

AVERAGE ANNUAL ARTIFICIAL FERTILIZER APPLICATION PER HECTARE OF AGRICULTURAL LAND
(in kilogrammes of pure chemical)[34]

| Period | Nitrogen (N) | Superphosphate ($P_2O$) | Potash ($K_2O$) |
|---|---|---|---|
| 1878/80 | 0.7 | 1.6 | 0.8 |
| 1898/1900 | 2.2 | 10.3 | 3.1 |
| 1913/14 | 6.4 | 18.9 | 16.7 |

The growth of artificial fertilizer consuption from the 1870s is indicated in Table I above, which shows that in little over 30 years there was over a ninefold increase in nitrogen applications, in excess of a twelvefold increase in superphosphate usage, and over a twentyfold increase in the use of potash as an artificial

[33] E. WELTE, 'Die Bedeutung der mineralischen Düngung und die Düngemittelindustrie in der letzten 100 Jahren', *Technik-Geschichte*, Vol. XXXV, No. 1, 1968, pp. 41-3; KIEHL, *op. cit.*, p. 91; F. SCHOTTE, *Die Productionsgrundlage der Provinz Sachsen*, (Dissertation: University of Halle, 1932; pub. Halle, 1932), pp. 155, 158.

[34] WELTE, *op. cit.*, p. 46.

fertilizer. By the eve of the First World War, German farmers were applying an average of three times the volume of artificial fertilizer per hectare of their French counterparts.[35]

As the basis of rotations in which they were usually followed by exhaustive cereals, and as the highest-yielding of temperate zone crops for carbohydrates, rootcrops required large applications of fertilizing inputs. To some extent these were met by applications of farmyard manure, but complete dependence upon this restricted the potential of the cycle of production. In other words, dependence upon farm sources of manure limited the yields of rootcrops which, as the source of fodder, in turn restricted the supply of manure. This cycle could only be broken by applying artificial fertilizers, which were also required to replace nutrients removed from the soil through the processing of beet into sugar, and of potatoes into alcohol and starch or for household consumption. In addition, artificial fertilizers, which were more rapidly absorbed by plants than the nutrients of manure, were applied to beet crops in order to force rapid early growth beyond the point at which they were susceptible to the ravages of the turnip-fly.

For the above reasons the usage of artificial fertilizers in German agriculture originated in the 1850s for the cultivation of rootcrops. In spite of subsequent application to other crops, which was initiated on rootcrops holdings, the root-break continued to absorb a large proportion of outlays upon artificial fertilizers. Crops of sugar beet received extremely high rates of application by contemporary standards. In the 1870s in the Madgeburg district of central Germany, which was widely acknowledged to be the most agriculturally advanced in the country, common rates of applications of nitrogen and superphosphate were from 80 to 100 kilogrammes per hectare for sugar beet and 32 to 48 kilogrammes for wheat. In the early 1880s it was not unknown for 100 ki-

[35] P. Hohenberg, *Chemicals in Western Europe: 1850-1914*, (Chicago, 1967), p. 49.

logrammes per acre of Chilean nitrates and 200 kilogrammes of superphosphate to be applied to sugar-beet crops on small peasant holdings, at a time when artificial fertilizers were rarely applied to the generality of crops grown on that category of holding. Typically, in one Hanoverian village on the eve of the World War the rate per hectare of artificial fertilizer used for sugar beet was three times that for cereals and the same rate of application was employed for potatoes as for cereals. On eight holdings of various types analysed by Lilienthal in the early 1890s, the total annual volume of artificial fertilizer increased by 35 per cent with the adoption of sugar-beet cultivation and on some of the holdings no artificials were used before sugar beet was first cultivated.[36]

It would be no exaggeration to state that the phenomenal growth of the artificial fertilizer industry in Germany, with its intimate links with both the chemical and heavy-industrial growth sectors of the economy as a whole, was primarily attributable to the expansion of rootcrop cultivation in German agriculture. In particular, the role of potatoes and sugar beet as the raw materials of processing industries, which yielded starch, alcohol and sugar, contributed substantially to the progress of knowledge on the efficacy of the various artificial fertilizers. These industries were dependent for their survival upon maximizing output of finished commodities per unit of raw material. In the case of sugar until the 1890s, the substantial excise duty was levied and progressively increased upon the raw material (on the basis of the notional sugar content rather than on the finished product) to give a tax-saving incentive to maximize the sugar-content of

[36] G. HUMBERT, *Agrarstatistische Untersuchungen über den Einfluss des Zuckerrübenbaues auf die Land- und Volkswirtschaft*, (Jena, 1877), p. 76n; W. GERLAND, 'Die Lage des Kleingrundbesitzes im ehemaligen Fürstentum Halberstadt', *Schriften des Vereins für Socialpolitik*, Vol. XXII, Part 2, 1883, p. 137; H. LAUENSTEIN, *Die Entwicklung eines neidersächsischen Bauerndorfes in den letzten 100 Jahren unter dem Einfluss von Besitzverschiebung, Industrie und Verkehr*, (Dissertation: University of Jena, 1922), p. 151; LILIENTHAL, *op. cit.*, p. 94; FRANZ, *op. cit.*, p. 909.

beet.[37] As the latter was especially influenced by the volumes and combinations of artificial fertilizers employed, processors were stimulated to undertake scientific experiments in this area. In addition, the transport costs involved in carrying rootcrops to processing plants of which the optimum scale was increasing rapidly during the century, and the growth of demand for the products of such activities, motivated efforts to widen the range of soils on which sugar beet and potatoes could be produced remuneratively by means of artificial fertilizers. In respect of sugar beet these experiments were so successful that, by the 1890s, it could be said that 'the capacity to produce sugar beet ... has spread, as a result of research on the application of artificial fertilizers, to areas that would have been considered twenty years ago as entirely unsuited to the cultivation of the crop.'[38]

The growth of knowledge and usage of artificial fertilizers on rootcrop holdings was primarily responsible for the later 19th-century breakthrough in Germany from rotational farming to "free economy" (*freie Wirtschaft*). Under the former a higher degree of flexibility in cropping sequences had been achieved than under the traditional three-field system and under subsequent modifications of that system. Nevertheless, the particular sequence adopted was largely fixed by the innate characteristics of the

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[37] From 1850 to 1869 an excise duty of 1.50 Marks per 100 kilogrammes was levied on sugar beet entering mills, on the assumption that it required 11 kilogrammes of beet to produce one of raw sugar. Insofar as sugarmillers were able to produce that amount of sugar with less beet the excess was duty-free. One sugarmill near Magdeburg, for example, required only from 10.2 to 10.65 kilogrammes of beet to produce one of sugar between 1858 and 1863. As the mill produced an average of 6,324 tonnes of raw sugar a year the excise duty should have amounted to 1,043,460 Marks (63,240 × 11 × 1.50). In practice the mill paid only from 967,572 Marks (63,240 × 10.2 × 1.50) to 995,882 (63,240 × 10.65 × 1.50) and saved from 4.6 to 7.3 per cent on tax outlay. (See W. Henneberg, 'Die neuere Entwicklung des Produktion und Besteuerung des Rübenzuckers im Deutschen Reiche', *Journal für Landwirtschaft*, Vol. XXXVI, 1888, pp. 363–444; W. Katzenstein, *Die deutsche Zuckerindustrie und Zuckerbesteuerung in ihrer geschichtlicher Entwicklung*, (Berlin, 1897), esp. p. 20; Schuchart, *op. cit.*, pp. 53–4, 56).

[38] H. von Mendel, *Fünfzig Jahre der Landwirtschaft der Provinz Sachsen im Lichte des Landwirtschaftlichen Zentralvereins*, (Berlin, 1894), p. 337.

farmer's land. A high degree of interdependence also existed between the various crops grown in the sequence and between the rotation and the livestock holding as the source of manure. "Free economy", on the other hand, meant the absence of a specific sequence of crops or rotation, in that by utilizing the freedom of action provided by artificial fertilizers the plan of cultivation for the farm was drawn up or revised annually in accordance with actual or anticipated relative prices for various crops. At the same time, artificial fertilizers enabled farmers to divorce the volume and types of livestock maintained on their holdings from the manure requirements of the the arable. Instead, the livestock branch of holdings came to be more or less exclusively oriented towards actual and potential returns from livestock sales and to the draft requirements of cultivation.[39]

Prototypes of "free economy" emerged earliest on sugar-beet holdings in central Germany, especially on farms operated by sugarmilling companies that desired to minimize the proportion of land devoted to other crops. In central Germany this type of farm was common by the 1890s and by the 1900s, sugar-beet farmers in the eastern province of Posen and elsewhere had moved beyond a strict adherence to integrated rotations.[40] As such this represented the original emergence of the most advanced European farming of the mid-20th century.

In relation to other crops including cereals, roots were remarkable for the degree of intensity and variety of process in cultivation. Initially, the stubbles of preceding grain crops were turned to a shallow depth immediately after the harvest, in order to maximize the exposure of the soil to the elements, rather than left for grazing

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[39] ALVERMANN, *op. cit.*, p. 22; P. TEICKE, 'Die landwirtschaftliche Verhältnisse des Zuckerrübenbauenden Teile der Provinz Hannover' in *Betriebsverhältnisse der Deutschen Landwirtschaft*, Vol. 1, (Arbeiten der Deutschen Landwirtschafts-Gesellschaft, No. 118, 1906), p. 29; BIELEFELDT, *op. cit.*, p. 75n.

[40] JUNGSER, *op. cit.*, p. 49; ALVERMANN, *op. cit.*, p. 22; TEICKE, *op. cit.*, p. 29; B. AMROGOWICZ, *Die Zuckerindustrie der Provinz Posen*, (Dissertation: University of Munich, 1903; pub. Berlin, 1903).

purposes to be ploughed later in autumn. For this purpose special stubble-ploughs were adopted from the 1860s and, subsequently, double-and triple-furrow became standard on rootcrop holdings. Later in autumn the land for roots was ploughed to a depth of up to 30 centimetres, or approximately double the customary depth for cereals. This acted as an important stimulus to the improvement of the design and quality of ploughs and was responsible for the diffusion of steamploughing from the 1860s. Steamploughs, in fact, became far more extensively used in Germany, especially on the large sugarbeet holdings, than in Britain where the technology was first developed. They were adopted not only to improve the quality of ploughing and to achieve the required depths, but also to enable autumn-ploughing to be completed when draft animals were in considerable demand to transport sugar beet to the mills and potatoes to the distilleries. In addition, steamploughs enabled the land to be cultivated in relatively wet conditions when the land was inaccessible to teams, and the greater speed with which the steamploughs passed through the ground more thoroughly loosened the soil for rootcrops.[41]

In spring the land was repeatedly harrowed and rolled to create the finest and firmest seedbed possible. Here the expansion of the rootcrops area contributed more than any other factor towards extending the range and improving the quality of harrows rollers, cultivators and extirpators. The necessity for row-cultivation with beet initiated the adoption of the seeddrill on German farms, and this implement was then subsequently extended

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[41] ZANDER, *op. cit.*, pp. 59-60; EYTH, *op. cit.*, p. 120; KIEHL, *op. cit.*, pp. 11, 16; K. KAERGER, 'Die Sachsengängerei', *Landwirtschaftliche Jahrbücher*, Vol. XIX, 1890, p. 247; W. CROOKES, *On the Manufacture of Beet-Root Sugar in England and Wales*, (London, 1830), p. 23; P. GUTKNECHT, *Studien über die technischen Organisation der Landwirtschaft in der Börde und den angrenzenden Gebieten unter Einfluss des intensiven Hackfruchtbaues*, (Arbeiter der Deutschen Landwirtschafts-Gesellschaft, No. 130, Berlin, 1907), p. 41; H. MOSEL, *Die Entwicklung der Zuckerfabrik Klein-Wanzleben vorm. Rabbethge und Giesecke A.-G.* (Dissertation: University of Würzburg, 1925; pub. Bernburg, 1925), p. 31; FRANZ, *op. cit.*, p. 907.

to the sowing of cereals-initially on rootcrop holdings. In late spring and early summer rootcrops were repeatedly hoed and hilled; with up to three horsehoeings and three handhoeings being applied to crops of beet. Of sugar beet, in particular, it was a saying that " the sugar is hoed into the beet " and it was observed that: ' sugar-beet yields are essentially dependent upon the correct timing of thinning out the plants and upon the hoeing '. Finally, the extreme bulk of roots to be harvested stimulated efforts to overcome the complex technical problems involved in developing potato and beet harvesters, which were approaching a satisfactory solution by the eve of the First World War.[42]

The intensive cultivatory practices associated with the growing of rootcrops were largely responsible for the progressive elimination of fallowing, or the periodic resting of land from crops, during the 19th-century. In turn, it was the reduction of fallowing through the cultivation of roots, which permitted the area devoted to these to expand without requiring a reduction of the cereals acreage. Admittedly, the diffusion of the " improved three-field system " in Germany from the end of the 18th-century had reduced the extent of bare fallows, by substituting nitrogen-fixing clover and legumes after two successive crops of cereals to restore the fertility of the soil. However, this innovation was insufficient for the elimination of periodic fallowing as a means of controlling weed-infestation, and as late as 1878 almost 15 per cent of arable land was fallowed. Alternatively, the frequent hoeings and the liberal applications of artificial fertilizers to rootcrops, and the

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[42] R. BERTHOLD, ' Die Entwicklung der deutschen Landwirtschaft von den Agrarreformen bis zum Ausbruch der allgemeinen Krise des Kapitalismus ', in V. KLEMMN (ed.), *Von der bürgerlichen Agrarreformen zur sozialistischen Landwirtschaft in der DDR*, (Berlin, 1977), p. 38; KIEHL, *op. cit.*, pp. 11, 85; GUTKNECHT, *op. cit.*, p. 43; G. SCHACK-SOMMER, *Home-Grown Sugar*, (London, 1890), p. 17; KAERGER, *op. cit.*, pp. 250-1; LILIENTHAL, *op. cit.*, pp. 17, 27; SCHUCHART, *op. cit.*, pp. 206-7; G. KÜHNE, ' Erntemaschinen ', in G. FISCHER (ed.), *op. cit.*, pp. 177-182. See also H. WINKEL, ' Zur Anwendung des technischen Fortschritts in der Landwirtschaft im ausgehenden 19. Jahrhundert ', *Zeitschrift für Agrargeschichte und Agrarsoziologie*, Vol. XXVI, No. 1, 1979, pp. 19-31.

large volume of livestock fodder they yielded for conversion into manure, enabled farmers to control the growth of weeds and maintain a high level of soil fertility without even occasional resort of fallowing. Thus, with the expansion of rootcrops cultivation, the area of fallows was almost halved between 1878 and 1900, from 2.31 to 1.23 million hectares, to become practically unknown on root-crop holdings. In addition, the increase of rootcrop cultivation contributed substantially to the decline of the practice of clover crops being left for more than a single year to produce a limited quantity of fodder.[43]

By considerably augmenting fodder production the expansion of the rootcrop area brought about a substantial increase in the ratio of livestock to land in Germany, which was far more substantial than would have been the case if agriculture had been extensified by the conversion of arable to pasture. The sugarmills, in particular, were considered ' the fodder factories of the agriculturalist ' because of the beet-pulp they returned to their suppliers. The tops of beet removed in harvesting and the beet-pulp together yielded the estimated fodder equivalent per hectare of clover and considerably more than a hectare of hay. Although yielding considerably less fodder per hectare than sugar beet, the far larger potato harvest provided an enormous absolute volume of fodder for livestock, either directly or as a waste product of the numerous potato-alcohol distilleries in the eastern territories.[44] Moreover, all forms of rootcrop fodder were available for fattening livestock during the winter months, when livestock prices ascended to a seasonal peak with the end of the grazing season.

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[43] HAGELBERG, *op. cit.*, p. 162; PAASCHE, *op. cit.*, p. 282; HUMBERT, *op. cit.*, pp. 16–17; BRUKNER, *op. cit.*, p. 36; " Home Counties " (J. W. ROBERTSON SCOTT), *Sugar Beet: Some Facts and Illusions*, (London, 1911), p. 5; KIEHL, *op. cit.*, p. 85; GUTKNECHT, *op. cit.* p. 85.

[44] ROEMER, *op. cit.*, pp. 39, 44–5; SCHOTTE, *op. cit.*, p. 62; JUNGSER, *op. cit.*, pp. 15–16; KELLERMANN, *op. cit.*, p. 297.

## III

The development of the forces of production in German agriculture on the basis of an expansion of the area devoted to rootcrops had a profound impact upon relations of production. Here the most significant developments of the period 1850 to 1914 included, firstly, a substantial rise in the price of land, which was sustained through the period of falling prices for agricultural commodities from the 1870s to the 1890s, and of indebtedness in the agricultural sector. Secondly, a tendency towards the concentration of landownership and holdings that was arrested towards the end of the century. Thirdly, although the proportion of the total labour force employed in the agricultural sector continuously declined from the 1850s, as late as 1914 over 30 per cent of employment was still generated by that sector and a substantial female agricultural labour force was retained.[45] Fourthly, agriculture was increasingly permeated by capitalist attitudes and practices and, in particular, the quasi-feudal employer-employee relations were modified in a capitalist direction. Finally, agriculture exhibited a growing dependence upon migratory seasonal-labour drawn from a widening radius of Europe. It is contended here that these developments owed more to the expansion of the rootcrop area than to any other factor, including the process of rapid industrialization and particularly the German protectionist response to the emerging world cereals economy.

It is widely accepted that the continued advance of prices for agricultural land from the 1870s to the 1890s was a consequence of the grain-tariff, which is assumed to have maintained agricul-

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[45] Germany retained a large proportion of its labour force in the agricultural sector even though, from the 1850s, that sector divested itself of a number of activities in the area of processing agricultural commodities and came to rely upon more and more productive inputs, such as machinery and artificial fertilizers, that were purchased from the industrial sector. (See K. BORCHARDT, 'Wirtschaftliches Wachstum und Wechsellagen 1800-1914', in H. AUBIN and W. ZORN (eds.) *Handbuch der deutschen Wirtschafts- und Sosialgeschichte*, Vol. II, (Stuttgar, 1976), p. 214.

tural incomes. At the same time, the tariff has been accused of stimulating speculation in the land market, which had the effect of raising prices above the value of land in production and of creating a growing debt burden in the agricultural sector. There is undoubtedly an element of truth in the latter statement as regards the short-term. However, it is difficult to conceive of the tariff as possessing the power to maintain land prices at speculative heights and to support a growing level of indebtedness. In practice, this was made possible by the intensification of production on the basis of an expansion of the rootcrop area, and the latter also contributed substantially to the speculation that occurred in the land market.

At various times after 1850 'unrealistic expectations that agriculturalists held of sugar-beet cultivation' and to a lesser extent of potato-growing, unleashed speculative forces in the land market, with 'unrealistic prices being paid for leases and purchases'. In central Germany, the region with the highest concentration of land under sugar beet: 'The rise of land prices was especially great in periods in prosperity for the sugar industry and of the expansion of sugar-beet cultivation'. In relation to the fixed net yield of land tax per hectare, indebtedness appears to have increased to a greater extent in the sugar-beet districts than elsewhere. For example, in the Prussian province of Saxony, which accounted for over 30 per cent of the German sugar beet area in 1890 indebtedness per *Reichsmark* of net land-tax yield rose by almost 30 per cent between 1883 and 1893 as compared with under 24 per cent for Prussia as a whole. In general, a positive correlation existed between the degree of intensity of cultivation and the increase in indebtedness. However, the continued intensification of production, and the long-term profitability of the sugar-beet and potato-alcohol industries, maintained the value of the land and ensured that the level of indebtedness in relation to that value did not increase substantially. In one central German county, for example, the total debt burden on 39 Junker estates rose by

34.5 per cent from 1861/80 to 1881/95, but as a proportion of the value of the land it only increased from 30.1 to 31.1 per cent.[46]

The advance of prices for established sugar-beet holdings contributed substantially to the increase of land prices elsewhere. In part this occurred as a consequence of the diffusion of the techniques of intensification to other types of farms producing different crops, which contributed towards improving their profitability. In part the growth of demand and the emphasis on quality of rearing stock and draft animals for sugar-beet holdings increased the demand for pastoral land for livestock breeding. More importantly, however, the high prices paid for sugar-beet land stimulated developments in artificial fertilizer production and plantbreeding designed to widen the range of soils on which the crop could be grown, and encouraged producers to purchase land in other parts of Germany that consequently became suitable for sugar-beet cultivation. Of Posen, for example, it was stated in the 1900s that: [47]

> the price of farms has increased considerably in the province since the establishment [in the 1880s] of the sugar industry. On the one hand, this has occurred as a consequence of the higher standard of farming and the related outlay of capital on the long-term improvement of land. On the other hand, farms in Posen province have been readily purchased by farmers from other parts of Germany, especially from Prussian Saxony and Mecklenburg, who were fully acquainted with the cultivation of sugar beet.

The novel demands of intensifying production upon farmers and the resulting rise in land prices stimulated a considerable turnover of landed property. Between 1835 and 1864 the 1,287

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[46] SCHUCHART, *op. cit.*, pp. 225, 227, 229; Gutknecht, *op. cit.*, p. 37; BIELEFELDT, *op. cit.*, p. 94; C. STEINBRÜCK, *Die Entwicklung der Preise des städtischen und ländlichen Immobiliarbesitzes zu Halle (Saale) und im Saalkreise*, (Jena, 1900), p. 53; JUNGSER, *op. cit.*, p. 20; STRAUSS, *op. cit.*, p. 102.

[47] AMROGOWICZ, *op. cit.*, p. 50.

Junker estates in Prussian Saxony experienced 944 changes of ownership through inheritance and 1,211 through sales. The latter changes, often involving the amalgamation of estates and the entry on non-nobles into the acquisition of former feudal patrimonies, undoubtedly caused a weakening of the traditional patriarchical relationships between landowners, peasants and agricultural workers that were sanctioned in the minds of the latter groups in part by the lengthy residence of particular Junker families.[48]

During the early stages of the expansion of the rootcrop area, or up to the 1870s, it appears to have contributed significantly to the concentration of landownership and holdings. The larger holdings of the Junkers and others were the earliest to be withdrawn from communal agricultural systems, to facilitate the cultivation of roots as field crops. They possessed greater capital resources, derived partly in the case of the Junkers from the redemption payments made by the peasantry for the removal of feudal obligations, and access to cheaper sources of credit, to meet the outlays required for rootcrop cultivation. In one central German community, for example, the absorption of 25 per cent of the small-peasant holdings into larger holdings was attributed to the inability of these *Kuhwirtschaften* — or holdings dependent upon cows for draft purposes — to meet the draft requirements of sugar-beet growing. In order to utilize to the maximum the raw-material capacity of sugarmills and distilleries erected on their holdings, for which the optimum scale of plant increased substantially as the century progressed, larger growers were motivated to buy additional land. Given the high costs of transporting bulky rootcrops from the land to processing plants, they acquired wherever possible the fields of their small neighbours. The devastations of nematodes in the middle decades of the century were also considered to

[48] Bielefeldt, *op. cit.*, p. 94; C. von Dietze, 'Die Vererbung des ländlichen Grundbesitzes in Mitteldeutschland', *Schriften des Vereins für Socialpolitik*, Vol. CLXXVIII, Part I, 1930, p. 221.

have stimulated growers to acquire more land in order to meet their commitments as suppliers of rootcrops or to keep their mills and distilleries in operation.[49] For these reasons higher prices per hectare were paid for small parcels of land than for entire holdings, which occasioned the demise of a number of peasant farms.

On the basis of rootcrop cultivation a number of exceptionally large holdings emerged. The Nagel farm near Halle, in central Germany, for example, originated in the early 1840s when two brothers abandoned their craft as stonemasons to purchase a farm of less than 100 hectares to grow sugar beet. A brickworks was established on the holding, principally to supply material for the construction of a sugarmill that was opened in 1848. Subsequently, a flourmill was added as well as a distillery to process potatoes and molasses into alcohol. The land area of the holding was steadily extended, by purchase and lease, to 1,414 hectares by the time the brothers died in the mid-1880s. By the 1900s their successors operated 2,146 hectares of land which supported two large sugarmills. In another case a farm of about 100 hectares purchased in 1848 had expanded to nearly 7,000 hectares by 1914.[50]

Up to the First World War there remained a particular concentration of rootcrop cultivation on larger holdings. As late as 1907, 54.2 per cent of the land devoted to sugar-beet was on farms of over 100 hectares in extent which occupied about a quarter of the agricultural area. Only 16.8 per cent of the sugar-beet area was accounted for by farms of under 20 hectares that occupied half of the agricultural area. Nevertheless, certain developments in the later 19th-century stimulated a wider social and geogra-

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[49] SCHMIDT, *op. cit.*, p. 14; SCHOTTE, *op. cit.*, p. 17; GUTKNECHT, *op. cit.*, pp. 37-8; BIELEFELDT, *op. cit.*, pp. 87-90.

[50] A. KOBE, *Entwicklung und Betriebsverhältnisse eines landwirtschaftlichen Grossbetriebes der Provinz Sachsen*, (Dissertation: University of Leipzig, 1925), pp. 12-17; MOSEL, *op. cit.*, p. 00; DIETZE, *op. cit.*, p. 224; See also H. SEIFFERT, 'Die Entwicklung der Familie von Alvensleben zu Junkerindustriellen', *Jahrbuch für Wirtschaftsgeschichte*, 1963, Part IV, pp. 209-43.

phical diffusion of sugar-beet cultivation. The first of these was the increasing economies of scale in sugarmilling, whereby the optimum scale of plant expanded to beyond a size for which the raw material could be supplied entirely from most individual large holdings. In response to this joint-stock companies and co-operatives of growers were formed to operate large mills; and with the progressive diminution of the scale of individual shares access to the profits of both growing and processing sugar beet was extended to smaller growers. Secondly, the later 19th-century witnessed a decline of vertical integration in the industry, whereby sugarmilling companies divested themselves of their large landholdings and increasingly relied upon the purchase of beet from growers. At the same time, the establishment of sugarmills by nonagricultural capitalists, in areas such as the Rhineland where small peasants prenominated, provided a market for the produce of small growers. Finally, the rise of real wages, and the increasing difficulty of obtaining an adequate supply of labour, enabled small peasants relying on family labour to compete with large growers.[51]

Another possible factor tending to arrest the concentration of landownership and holdings from the later 19th-century was suggested by Max Weber in 1894. According to Weber the increasing capital-intensity of cultivation produced a stagnation and even a decline in the area of individual large estates, with owners divesting themselves of a proportion of their land to raise the capital required for intensified production on the remainder.[52] In addition, a reduction in the optimum size of

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[51] SCHOTTE, *op. cit.*, pp. 61-2; R. FREUND, 'Strukturwandlungen der internationalen Zuckerwirtschaft', *Weltwirtschaftliche Archiv*, Vol. XXVIII, 1928, (Chronik und Archivalien), p. 9; BREINLINGER, *op. cit.*, pp. 105-7; GERLAND, *op. cit.*, pp. 133, 148-9; *Die deutsche Zuckerindustrie*, (*Berichte über Landwirtschaft*, new series, Supplement, XVIII, Berlin, 1931, p. 56; SCHOTTE, *op. cit.*, p. 71; PAASCHE, *op. cit.*, p. 287n; K. PFEIFFER, *Geschichte der Rübenzuckerindustrie in der Rheinprovinz* (Bonn, 1922), pp. 86-7.

[52] M. WEBER, 'Entwicklungstendenzen in der Lage der ostelbischen Landarbeiter', *Preussische Jahrbücher*, Vol. LXXVII, 1894, p. 442.

holdings may have occurred in consequence of the enhanced entrepreneurial managerial skills required for intensive farming. As one writer observed in 1907: [53]

> Although it is difficult to compare the profitability of different farms, it appears to be the case that with intensive cultivation the advantage lies precisely with those holdings whose size permit the operator to do without supervisory personnel and personally to control the teams and workers.

In respect of employment rootcrop cultivation was particularly notable for an inordinately large demand for labour per unit of land and for a pronounced seasonality of labour requirements In Mecklenburg in the early 1890s, estimated adult labour-days applied per hectare ranged from 77.9 on holdings devoted to cereals, legumes and pasture leys, through 110.0 on farms with over 20 per cent of arable land devoted to rootcrops other than sugar-beet, to 173.0 on holdings with over 20 per cent of the land devoted to sugar beet. In the 1900s the outlay per hectare upon labour for sugar-beet cultivation was calculated to be 2.5 times that for wheat and three times that for rye. On one central German farm in 1913 payments per hectare for labour ranged from 51 marks for cereals through 92 marks for potatoes to 118 for sugars beet. According to an index of average labour requirements for crops from 1884 to 1923, taking wheat as 100, the figure was 83 for barley, 311 for potatoes, 342 for mangolds and 375 for sugar beet. Overall, at a conservative estimate rootcrops involved at least double the outlay upon labour per hectare of cereals. The ratio of labour costs between the least-intensive field system — the three-field with extensive pasture — and the most-intensive — a substantial proportion of the holding devoted to sugar beet — has been calculated at 1: 4.30; although one source puts it

[53] GUTKNECHT, 1907, p. 38.

as high as 1: 9.67 and another estimates the ratio between the improved three-field system and a sugar beet holding at 1: 4.57.[54]

Estimates of the comparative summer and winter labour requirements of different field systems also vary considerably. According to one the ratio of winter to summer employment ranged from 1: 1.71 for the three-field system, through 1: 3.88 for the Norfolk four-course rotation with a quarter of arable under fodder roots, to 1: 5.73 on sugar-beet holdings. According to another estimate the range was 1: 1.5, 1: 1.9 to 1: 2.6 respectively. Nevertheless, in addition to the diffusion of the threshing-machine displacing winter hand-labour with the flail, it was accepted as self-evident by most contemporaries that the expansion of the rootcrop area had brought about a marked increase in the seasonal variation of employment in the agricultural sector. As one writer described conditions in the Magdeburg district in the 1900s: 'The threshing-machine and sugar-beet cultivation have made agriculture more and more of a seasonal activity, with a three-month pause during winter during which nothing like the number of summer workers are able to find employment'. At the same time, within the summer season, the adoption of rootcrop cultivation probably reduced the periodicity of employment by creating work in hoeing and hilling etc. between sowing and the harvest.[55]

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[54] W. Wygodzinski, *Die Landarbeiterfrage in Deutschland*, (Tübingen, 1917), p. 13; A. G. Dade, *Die deutsche Landwirtschaft unter Kaiser Wilhelm II*, Vol. I, (Halle, 1913), p. 419; Radetzki, *op. cit.*, p. 307; B. Sagawe, 'Die wirtschaftliche Bedeutung des Rübenbaues', *Archiv für exakte Wirtschaftsforschung*, Vol. VI, 1915, pp. 158-9; A. Münzinger, 'Die Bedeutung des Hackfruchtbaues in der Betriebsorganisation', *Zeitschrift für Zuckerrübenbau*, Vol. VIII, 1926, p. 134; A. Bridges and R. N. Dixey, *Sugar Beet in France, Belgium, Holland and Germany*, (Oxford, 1928), p. 5; Brukner, *op. cit.*, pp. 9-10; R. Weber, *Arbeitsbedarf und Arbeitsverteilung bei verschiedenen Anbauverhältnisse der Früchte*, (Berlin, 1930), p. 6; F. Dettweiler, *Die Handarbeit in der Landwirtschaft*, (Jena, 1905), p. 143.

[55] Schuchart, *op. cit.*, pp. 205-6; Gutknecht, *op. cit.*, p. 112; Wygodzinski, *op. cit.*, p. 11; M. Weber, *op. cit.*, pp. 457-8; Raderzki, *op. cit.*, p. 307; W. Radetzki, *Die inlandischen Wanderarbeiter Deutschlands*, (Dissertation: University of Breslau, (Wroclaw, 1930), p. 17; J. Conrad, *Grundriss zum Studium der politischen Oekonomie*, Part II, *Volkswirtschaftspolitik*, (7th end., Jena, 1919), p. 123.

The expansion of rootcrop cultivation, with its extraordinarily heavy demand for labour and pronounced seasonality of employment, had a profound impact upon the form and structure of the agricultural labour force. In the middle decades of the century the adoption of sugar beet, in particular, contributed significantly to the demise of feudal rent in the form of labour services on the lord's demesne and tribute from peasant holdings. The latter came to be viewed as a disincentive to peasant initiative in responding to the stimulus emanating from the sugar-beet industry. The labour services of serf-peasants were especially considered inadequate in terms of the quantity and quality of the work for the successful cultivation of sugar beet. As an Austrian writer observed in 1848:[56]

> The cultivation of sugar beet is incompatible with labour services; instead it demands free labourers. This is the reason why in France and northern Germany yields are between 1,700 and 2,000 kilogrammes while in Austria they are only between 1,000 and 1,500... Through the system of labour services the peasant has to a certain extent been taught laziness and to neglect his labour.

In Germany during the second half of the century the expansion of the sugar-beet area acted to transform the labour system that evolved with the process of emancipation of the peasantry from serfdom during the early decades of the century.

Broadly speaking, the labour force that replaced serfdom in Germany's eastern territories consisted of farm-servants (*Knechte*) and cottagers (*Instleute*). The former were employed under contracts, usually renewed annually, and were boarded on the farm principally to work with draft animals. The latter were provided with land, from which they derived a large proportion of their income directly and through the sale of surplus produce.

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[56] J. RAD, *Der Rübenzucker in national-ökonomischen, finanziellen, industriellen und landwirtschaftlichen Bedeutung* (1848), cited in SCHUCHART, *op. cit.*, pp. 194–5.

In return they were obliged to work whenever required on their landlord's holding and to provide an additional worker (*Hofgänger*) for that purpose. During winter the *Instleute* and his *Hofgänger* were usually employed in threshing corn with the flail, for which they received a proportion of the grain as payment. The most significant feature of the *Instleute* system was that, through the occupation of land and his proportion of the threshing, the worker retained a high degree of identity of interests with those of his employer in respect of the state of the harvest and of market prices for agricultural produce.[57]

During the middle decades of the century the *Instleute* of the eastern territories was transformed into the confined labourer (or *Deputant*). This involved a considerable reduction in the land area that the worker operated himself, until it was generally confined to a small potato-patch which was often cultivated as part of his employer's holding. Here, apart from the growing surplus of agricultural labour, the increasing value of land and its produce with the intensification of production motivated farmers to incorporate land formerly allocated to workers into their holdings. Instead, the *Deputant* was mainly paid in kind with a fixed bundle of commodities determined in the concract of employment and a proportion of grain threshed over winter. Under this sytem the worker became far more of an economic object than subject, in that his consumption was largely pre-determined by his employer. At the same time, the degree of identity of interests between employer and employee was considerably reduced in contrast to the *Instleute* system, although a rather tenuous relationship continued to exist between the work-effort and the income of the labourer.[58]

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[57] See M. Weber, *op. cit.*, pp. 446-8; F. Aereboe, *Vergangenheit und Zukunft der Lohnungsmethoden in der deutschen Landwirtschaft*, (Betriebswirtschaftliche Vorträge aus dem Gebiete der Landwirtschaft, No. 5, Berlin, 1920).

[58] *Ibid.*; Kaerger, *op. cit.*, pp. 259-60; Radetzki (1930), *op. cit.*, p. 8; Breinlinger, *op. cit.*, p. 25; Aereboe, *op. cit.*, pp. 5-7.

In the sugar-beet districts from the 1830s onwards a gradual shift occurred from the *Instleute* and *Deputant* systems to a dependence upon wage-labour: a process that was virtually completed by the 1860s. Initially, such labour was paid by the day and almost entirely in cash. Increasingly, however, cash-payments for the task or piece-rates were applied wherever possible, and where day-rates were retained a fixed working day of twelve hours in summer was adopted during the later XIXth-century. To some extent this development was a response to the competition of industry and mining for labour, which forced farmers to concede similar terms of employment. Equally important, however, was the influence of the growth of the sugar-beet industry itself upon the quantitative and qualitative demand for labour and the pronounced seasonality of employment. The productivity of day-labourers, who were usually paid weekly, was noticeably higher than that of cottagers and confined labourers because a more direct relationship existed between their work-effort and their income. Day-labourers could be laid off during winter or periods of adverse weather conditions; and their work-effort was stimulated by the fact that they had no land of their own to provide an alternative source of income.

The demand and price of land for sugar-beet cultivation motivated farmers to restrict the land area allocated to their workers. The payment by cash instead of kind was more convenient for the entirely market-oriented sugar-beet farmers. A necessity to meet directly the food requirements of their workers would have interfered with the operation of integrated rotations designed to maximize sugar-beet yields. The calculation of piece-rates in kind, which were considered to improve productivity by at least 50 per cent over day rates, would have been unnecessarily complicated. Moreover, as one writer observed: 'Payment in kind could not be maintained in the long-term with rootcrop cultivation, not least because of the numbers of workers involved

and because they were successively employed on agricultural holdings and in processing plants '.[59]

From its basis in the sugar-beet districts, especially those of central Germany, the wage-labour system was gradually diffused in the eastern territories during the later 19th-century: but not without opposition. At the Berlin Conference of Agricultural Employers in 1872, which was called primarily in response to the agricultural strikes and lock-outs in England, Junkers from Prussian Saxony pressed the advantages of the system upon those of the more easterly provinces. The latter remained sceptical, believing that the confined-labour system, payment in kind and provision of land were necessary to procure an adequate supply of deferential workers. One went so far as to state that: ' In our part of the country the situation is such that all of the people would emigrate if they possessed the necessary cash '. Moreover, it was considered, through its effects upon the labour system in central Germany, that ' with intensive cultivation the relations between master and worker had become generally colder? [60]

In practice, the wage-labour system initiated on sugar-beet holdings proved to be a medium for the transition of agricultural into industrial proletarians. The labour-system came to approximate closely to that of industrial enterprises. The worker became adjusted to the ' equivalence ' principle of payment for labour in relation to actual performance. The traditional patriarchical relationships of agriculture were considerably weakened by the substitution of cash payments and piece-rates for payment in

[59] GUTKNECHT, *op. cit.*, p. 109; F. DANNEILL, *Die Arbeiterfrage im Lichte der Inneren Mission*, (Halle, 1873), p. 35; M. WEBER, *op. cit.*, p. 466; F. GROSSMANN, ' Die ländlichen Arbeiterverhältnisse in der Provinz Schleswig-Holstein (exkl. Kreis Herzogtum Lauenberg), den Provinzen Sachsen (exkl. der Kreise Schleusingen und Ziegenrück) und Hannover (südl. Teil), sowie den Herzogtümern Braunschweig und Anhalt ', *Schriften des Vereins für Socialpolitik*, Vol. LIV, *Die Verhältnisse der Landarbeiter in Deutschland*, Vol. II, 1882, p. 497; STRAUSS, *op. cit.*, pp. 172-5, 190; BIELEFELDT, *op. cit.*, p. 58.

[60] T. VON DER GOLTZ, *Die Verhandlungen der Berliner Conferenz ländlicher Arbeitgeber*, (Danzig, 1872), pp. 11-14, 16, 20, 64-8; GROSSMANN, *op. cit.*, p. 504.

kind. For contemporaries this was expressed in an assumed high level of immorality and declining church attendance amongst wage labourers. Of Pommerania in the 1900s it was observed that: 'The most religious piety is to be found amongst the peasants and property-owners and in part amongst the confined labourers; the least church-oriented are the day labourers'. The worker himself became an economic subject rather than object in that he was responsible for the disposition of his own income, which raised his consumption aspirations. And with the removal of his land allocation or possession the strongest tie of the worker to the countryside and agricultural employment was effectively removed.[61] Nevertheless, in order to satisfy the labour requirements of intensifying production on the basis of rootcrops in the face of growing urban-industrial competition for labour, Junkers in the eastern territories were increasingly compelled to imitate those of central Germany.

Perhaps the most significant consequence of the expansion of the German rootcrop area for the agricultural labour market, and especially that of sugar beet — was a growing dependence upon migratory workers. Admittedly, seasonal migration connected with the cereals harvest and with specialist industrial crops existed within Germany long before the XIXth century. But as a mass movement it effectively dates from the 1840s with the seasonal movement of small peasants from the Eichsfeld district near Erfurt to work on the sugar-beet holdings of the Magdeburg — Halle district of Prussian Saxony. Subsequently, although the movement drew in many other areas and involved seasonal migration to various parts of Germany, the term *Sachsengängerei* (Saxony-going) was retained to describe the phenomenon as a whole; not least because the sugar-beet fields of Prussian Saxony continued to employ a substantial proportion of the migrants.[62]

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[61] BREINLINGER, *op. cit.*, p. 64; M. WEBER, *op. cit.*, p. 466; SCHUCHART, *op. cit.*, p. 240.
[62] See KAERGER, *op. cit.*, RADETZKI (1926 and 1930), *op. cit.*, M. WEBER, *op. cit.*, p. 460.

By the 1870s large numbers of German and Polish agricultural workers from the eastern territories, especially from Posen, were engaged in seasonal labour in the sugar-beet districts of central Germany. In place of these workers numbers of Polish seasonal labourers from Russian-Poland and the Austrian province of Galicia began to enter Germany to work on farms in the eastern territories. By the later 1880s the number of foreign seasonal workers began to reach substantial proportions and more were directly entering the labour market of central German agriculture. From Russian-Poland alone 17,000 seasonal labourers are estimated to have sought agricultural work in Germany in 1890; and in 1891, according to official figures, 27,700 migratory agricultural workers entered Germany from Russian-Poland and Galicia. By 1900 the number of Russian Poles had risen to estimated 119,000, and by 1914 the official figure for legimate foreign seasonal workers employed in agriculture had risen to 433,000. Although these included Italians, Scandinavians, White Russians, and Ruthenians from Galicia, the majority were Poles.[63]

The official figures understate the actual number of foreign seasonal workers employed in German agriculture, in that many entered the country illegally. They underestimate the total movement of seasonal labour in that a large number of agricultural workers from the eastern territories continued to seek such employment on farms in the central and western regions of Germany. According to one estimate the number of seasonal migrants from Posen increased from 15,000 to 42,000 from 1889 to 1900, and a total of 87,000 workers from the eastern territories sought seasonal work in other parts of Germany in 1892. By 1907, when only about 300,000 foreign seasonal workers entered legally to work on farms, about 10 per cent of those engaged in agriculture (including farmers and supervisory workers) and approximately 30 per cent of employees were seasonal workers. The proportion

[63] Radetzki, (1930), *op. cit.*, pp. 29-30.

varied considerably according to region, with those in which root crops and especially sugar beet were concentrated being particularly dependent on seasonal labour. In the county of Neuhaldensleben, Prussian Saxony, in 1907 almost a third of the arable acreage was occupied by sugar beet and 32.5 per cent of those engaged in agriculture and 57.5 per cent of the agricultural labour-force consisted of seasonal migrants. On 40 farms in central Germany studied by Gutknecht in 1907, 63 per cent of the work-force consisted of seasonal labourers. In other areas, such as south and southwest Germany, such a form of agricultural labour was relatively unknown.[64]

A notable feature of seasonal migration in German agriculture from the 1840s was the high proportion of female workers. Of the estimated 87,000 migratory workers from the eastern territories in 1892 three-fifths were female. Over half of the foreign seasonal workers entering Germany were women as were about 90 per cent of those recruited by the German Labour Centre in 1914. The significance of women in this respect reflected the role of rootcrop cultivation in the employment of seasonal workers. On the 40 rootcrop holdings studied by Gutknecht in 1907, women accounted for 72 per cent of the 2,509 migratory workers employed. On a large sugar-beet holding in Prussian Saxony in the mid-1880s, 140 out of 180 seasonal migrants were female. In the county of Neuhaldensleben in 1907 72 per cent of seasonal migrants and 58 per cent of the total labour force consisted of female migratory workers.[65]

Women were found to be ideally suited in respect of aptitude and cost for a large proportion of the labour associated with the growing of rootcrops, from hoeing, thinning and hilling to lifting and gathering, and migratory women were more adapted than the indigenous to the requirements of rootcrop farmers.

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[64] *Ibid.*, p. 24; AMROGOWICZ, *op. cit.*, p. 81; BERTHOLD, (1974), *op. cit.*, p. 84; STRAUSS, *op. cit.*, p. 176; GUTKNECHT, *op. cit.*, p. 111.

[65] R. WEBER, *op. cit.*, p. 17; GROSSMANN, *op. cit.*, p. 483.

The supply to the farmer was virtually unlimited whereas the actual and potential indigenous female labour force was constantly diminishing. Migration from the rural districts included a disproportionate number of females and the improvement of the real wages of male rural workers lessened the degree of dependence of families upon the earnings of wives. To some extent heads of households were moved to withdraw the labour of their wives with the reduction in the status of female agricultural work caused by the appearance of increasing numbers of foreign and poor female migratory workers. The latter were increasingly preferred by farmers because, once they were recruited, they formed a reliable source of labour for tasks in rootcrop cultivation requiring punctuality and expedition. On the other hand, family circumstances and household plots occasioned a high level of absenteeism amongst the indigenous female labour force. In general, both female and male migratory workers were hired in increasing numbers because 'they were easy to acquire and then to dispose of, [and] they were not demanding in respect of board and lodging'.[66]

## IV

As the foregoing analysis indicates, the rapid expansion of the area devoted to rootcrops from the 1850s had profound effects upon agriculture as a whole and upon agrarian society in Germany. It was in fact the basis of the modernization of agriculture, in that it acted to transform the archaic field systems, techniques and technology of cultivation, and initiated the development of scientific plant breeding and protection as well as the the usage of artificial fertilizers. Moreover, and contrary to the view expressed by a number of historians, yields of other crops, and especially cereals, increased substantially as a consequence of the expansion of the area devoted to roots.

[66] *Die deutsche Zuckerindustrie*, *op. cit.*, p. 43; GROSSMANN, *op. cit.*, p. 485; DETTWEILER, *op. cit.*, p. 152.

Admittedly the data on yields are not absolutely reliable. As a German agricultural writer stated in 1910: 'The stepchild of agricultural statistics is the harvest statistic. In all countries even today this is nothing more than conjectural data or a summation of individual estimates'. From 1878 to 1898 in Germany the harvest statistics were estimates made by parochial authorities and from 1898 these were superseded by the samplings of experts. It has been suggested that the latter method produced lower estimates of yields than the former. Nevertheless, assuming the degree of error to be constant in both methods, the figures do indicate quite substantial increases of yields within the period in which each method was practised. From 1880 to 1898 wheat yields rose by about 20 per cent and those of rye by 23 per cent. The five-year average wheat yield increased by 29 per cent from 1899/1903 to 1904/1908, that of rye by 36 per cent and that of barley by 26 per cent.[67]

The expansion of the area devoted to rootcrops undoubtedly made a major contribution to the increase of cereals yields per hectare, either directly through the cultivatory practices associated with such crops and the expansion of manure supplies from fodder derivatives, or indirectly through increased outlays upon artificial fertilizers for roots which also beneficted succeeding crops in rotations. According to one estimate for Prussian Saxony shortly before the First World War, yields of rye varied 34 per cent from holdings not growing sugar-beet to those with 16 to 25 per cent of arable devoted to that crop. However, the possibility of sugar beet being concentrated on the more fertile soils is ignored. A more reliable estimate was made by Lilienthal in his study of the eight farms in the Kingdom of Saxony before and after the adoption of sugar beet in the early 1890s. According to that study sugar-beet cultivation was responsible for an increase of 18 per cent in wheat yields, of 16 per cent in those of barley

[67] BALLOD, *op. cit.*, pp. 431, 435; SCHUCHART, *op. cit.*, p. 223.

and of 5 per cent in those of rye. One German agricultural scientist writing in the 1920s went so far as to attribute the substantial decline in grain yields during the First World War entirely to the 50 per cent reduction in the sugar beet area.[68] And although this ignores other factors, such as the deterioration of labour supply and the availability of artificial fertilizers, the reduction of the sugar beet area did make a substantial contribution.

Through its effects upon soil structure the expansion of the area devoted to rootcrops made a notable contribution towards reducing fluctuations from year in cereal yields. At the same time it effected a qualitative improvement in German cereals production by permitting a shift from inferior grains such as rye and fodder barley to wheat and malting barley. Wheat, in particular, was said to have 'followed in the footsteps of sugar beet cultivation' and the cultivation of roots often enabled improved English varieties of wheat to be substituted for the traditional sorts. On the other hand, the uniform amount of duty levied upon all types of cereals under the grain-tariff from 1879 to 1902, insofar as it was effective, should have encouraged a shift to rye and fodder barley for which the costs of production were appreciably lower. At the same time, the fact that the advance in rye yields was far less in the 1880s than in the 1890s has been attributed to diffusion of sugar beet cultivation to the rye-producing districts being largely delayed until the latter decade.[69]

The advance in rootcrop yields mirrored that of cereals from the 1870s onwards. The five-year average of potato yields per hectare increased by 23 per cent from 1888/92 to 1898/1902. Subsequently, they virtually stagnated, rising only by 5.5 per cent

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[68] H. Raab, 'Rübenzuckerfragen', *Landwirtschaftliche Jahrbücher*, Vol. LXVII, 1928, pp. 174–6; Lilienthal, *op. cit.*, p. 85; Roemer, *op. cit.*, p. 23. See also Humbert, *op. cit.*, p. 35; Brukner, *op. cit.*, p. 2.

[69] Roemer, *op. cit.*, p. 22; H. von Mendel, 'Entwicklung der Landwirtschaft in der Provinz Sachsen innerhalb der letzten 12 Jahre', *Jahrbuch der Deutschen Landwirtschafts-Gesellschaft*, Vol. XVI, 1901, p. 153; Schuchart, *op. cit.*, p. 223.

between 1898/1902 and 1908/1912, although yields in the latter period were considerably deflated by the single disastrous harvest of 1911. For sugar beet the relevant statistics for yields are for raw sugar rather than for beet, in that the objective of cultivation was to maximize the yield of the former which often involved a reduction of the latter. Here from 1876/80 to 1896/1900 the sugar content of the beet harvest rose from 8.8 to 13.3 per cent or an increase of 51 per cent. By 1911/15 it had risen to 15.7 per cent or by a further 18 per cent.[70]

The increase in yields of cereals stemming from the expansion of the area devoted to rootcrops provided considerable assistance to German farmers in combating the substantial fall in prices from the 1870s to the 1890s, which the tariff was unable to prevent. At the same time, the expansion of the rootcrop area represented the German form of adjustment to relative price and demand movements for agricultural commodities during that period. Admittedly, the prices of sugar, alcohol and starch declined markedly in the later 19th century along with those of cereals. However, to a greater extent than in the case of grain crops, producers were compensated by falling costs of production and by the growth of demand. The cost of producing 50 kilogrammes of raw sugar at the large mill at Kruschwitz in the province of Posen, for example, declined from 17.60 Reichmarks in the season 1883/4 to 7.85 Reichmarks in that of 1895/6.[71]

Analysis of German demand for sugar between 1850 and 1914 indicates that price and income elasticity exceeded 1, whereas for cereals they were less than 1. In other words, the fall in the price of sugar and the rise of incomes during that period brought a disproportionate increase in demand. The income elasticity

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[70] BRUKNER, *op. cit.*, p. 61; E. O. VON LIPPMANN, *Die Entwicklung der deutschen Zuckerindustrie von 1850 bis 1900* (Leipzig, 1900) pp. vi-vii; R. E. GROTKASS, 'Die Weltanbaufläche von Rübe und Rohr und ihre Zuckererträge', *Zeitschrift des Vereins der deutschen Zuckerindustrie*, Vol. LXXVII, 1927, p. 313.

[71] AMROGOWICZ, *op. cit.*, pp. 64-5.

of demand for sugar was in fact greater than that for pigmeat, the livestock product most responsive to the advance of real incomes between 1850 and 1914. The average cross-price elasticity of demand for sugar was negative and greater than 1, so that decreases in the prices of other commodities — especially those of other foodstuffs as occurred from the 1870s to the 1890s — resulted in a disproportionate rise in the demand for sugar. This is reflected in the data on consumption in Germany. Per capita annual sugar consumption increased from an average of 6.5 kilogrammes for the period 1871/75 to 14 kilogrammes for 1895/99. The average annual per capita consumption of potatoes increased from 119.4 Kilogrammes in the period 1850/4 to 246.1 kilogrammes in the period 1910/13. The proportion of consumer income expended on sugar rose from 1.3 per cent in the quiquennium 1880/85 to 2.4 per cent in that of 1895/99. At the same time the proportion expended on potatoes increased from 6.1 to 6.9 per cent, while that devoted to rye-flour declined from 12.1 to 10.3 per cent.[72]

Perhaps a more significant agricultural adjustment occurring as a consequence of the expansion of the rootcrop area was the expansion of the livestock sector on the basis of the fodder produced from roots. This took the form of potatoes, fodder roots and sugar-beet tops fed directly to livestock, and the by-products of beet and potato pulp and molasses supplied by the sugarmills and distilleries. An indication of the very high correlation between the proportion of land devoted to sugar beet and the number of cattle per 100 hectares maintained on holdings is provided by Table II below, which is derived from an analysis of 738 farms in the 1910s. According to this table holdings with a quarter of

[72] W. G. Hoffmann, *Das Wachstum der deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts* (Berlin, 1965), pp. 120-1, 125; N. Kaumanns, *Die volkswirtschaftliche Bedeutung des Rübenzuckers für Deutschland* (Berlin, 1904), p. 16; H. J. Teuteberg, 'Zur sozialgeschichtlichen Bedeutung der Kartoffel und ihrer Eingliederung in die deutsche Volkskost', *Ethnologische Nahrungsforschung* (Helsinki, 1975) p. 259.

TABLE II

SUGAR BEET AND CATTLE NUMBERS IN PRUSSIAN SAXONY [73]

| Proportion of Area of Holding devoted to Sugar Beet (%) | Cattle per 100 hectares of land |
|---|---|
| Up to 5 | 43.3 |
| 6 to 10 | 57.6 |
| 11 to 15 | 60.7 |
| 16 to 25 | 63.0 |

their land devoted to sugar beet supported at least 50 per cent more cattle than holdings not growing that crop. In another example, by 1889, or some seven years after the adoption of sugar beet cultivation, the number of *Grossvieh* (or livestock expressed according to the ratio of 1horse = 1 head of cattle = 4 pigs = 10 sheep) on a large holding in the province of Posen had increased by 30 per cent without addition to the land area. A sample of 40 Hanoverian farms in the early 1900s indicates that the extent of land per *Grossvieh* varied from 1.40 hectares on sugar beet holdings to 1.68 on other rootcrop holdings, to 1.81 on cereal farms not supporting rootcrops.[74]

The fact that, in contrast to grass, root-crop fodder was mostly fed to livestock in stalls, enabled farmers more precisely to calculate the relationship between the fodder intake and the weight-gain or milk-yield of individual cattle. In turn, this stimulated the efforts of livestock breeders to improve the latter attributes of progeny. The high bulk-to-value ratio of rootcrop fodder and the expense of stall-feeding also acted to encourage efforts to develop drying processes to reduce the moisture content of sugar beet and potato pulp. By the late 1880s dried pulp was available with about 10 per cent of the original weight, which created a market for pulp-fodder in place of its being necessarily returned for the use of the actual growers. This development, in conjunc-

[73] RAAB, *op. cit.*, pp. 174–6.

[74] AMROGOWICZ, *op. cit.*, p. 76; TEICKE, *op. cit.*, p. 35.

tion with increased rates of artificial fertilizer application, enabled the latter to base the extent of their livestock holdings upon prices for livestock products rather than upon the volume of rootcrop fodder yielded by their land. The more concentrated dry fodder also enabled rootcrop growers to adopt livestock breeding and rearing, in addition to fattening and dairying, without running the risks attached to dependence upon watery fodder with its tendency to promote a high abortion rate in livestock.[75]

Overall, and primarily as a consequence of the expansion of the rootcrop area, the transformation of German agriculture during the second half of the 19th century amounted to an agricultural revolution. In the 1840s farming in that country was amongst the most backward in Europe. The extensive contemporary testimony of foreign observers with agricultural knowledge supports this observation. For example, a Dutch farmer who migrated to Germany in the late 1840s was amazed at the relative inefficiency of farming in the latter country and in particular he was dismayed at the poor quality of ploughs and ploughing.[76] Improved farming at that time and for less a decade or so afterwards largely consisted of the imitation of British and then American innovations. By the 1900s, on the other hand, German agriculturalists could claim with some justification that farming in their country was the most advanced in Europe, with the possible exception of that in Denmark.

The standard of agriculture in Germany by the 1900s was reflected in comparative yields for major crops, which is illustrated in Table III below. In general, by the late 1900s German yields were considerably in excess of those in the other continental countries and closely rivalled those of Britain. In comparing Britain with Germany it has to be borne in mind that, by the

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[75] SCHACK-SOMMER, *op. cit.*, pp. 31-2; KIEHL, *op. cit.*, pp. 116-7; GUTKNECHT, *op. cit.*, p. 69.

[76] KIEHL, *op. cit.*, pp. 80-1; See also.

TABLE III

FIVE-YEAR AVERAGE YIELDS PER HECTARE, 1906/10
(in Kilogrammes) [77]

| Country | Wheat | Rye | Barley | Oats | Potatoes |
|---|---|---|---|---|---|
| Germany | 201 | 170 | 196 | 197 | 136 |
| Great Britain | 221 | 182 | 196 | 189 | 138 |
| France | 136 | 106 | 130 | 126 | 86 |
| Austria | 132 | 131 | 142 | 123 | 108 |
| Italy | 93 | 109 | 89 | 103 | 60 |

1900s, the cereals area in the former country had experienced a pronounced retreat from the margin of relatively fertile land, whereas in the latter country it had expanded. Moreover, climatic conditions in a large part of Germany, where the winters were particulary severe, often precluded the cultivation of high-yielding British varieties of wheat.[78]

In the cultivation of sugar beet Germany was acknowledged as the leading country in the world. In the 1913/14 season the average sugar beet yield per hectare was 13 per cent higher than in France and 24 per cent above that of Austria-Hungary. By the eve of the First World War Germany accounted for 21 per cent of the world sugar-beet area and 30 per cent of world beet-sugar output. The average raw sugar yield per hectare in Germany, at 5.10 tonnes, was 38 per cent higher that of France and 31 per cent above that of Austria-Hungary. Germany from the mid-19th century took over from France the leadership in scientific research and field experimentation with sugar beet, and by the end of the century this had been extended to a range of other crops. By the 1900s Germany was the source of most of the growing volume of sugar-beet seed entering international trade. In 1912 approxi-

[77] BRUKNER, *op. cit.*, p. 61.
[78] *Ibid.*

mately 90,000 tonnes of seed were produced in Germany, of which some 57,000 tonnes were exported.[79]

In the middle decades of the 19th century numerous German farmers and agricultural scientists travelled abroad in search of knowledge of innovations and for training. German agriculture at that time relied heavily upon imported knowledge, especially from Britain, with most advanced agricultural machinery being either imported or manufactured by local subsidiaries of British firms. By the end of the 19th century, however, Germany had become a considerable exporter of agricultural machinery, artificial fertilizers and seed. Numerous foreign farmers visited the country in search of agricultural knowledge and its universities were training large numbers of agricultural scientists from abroad. In 1910 a German observer was able to boast that: 'Practical farming and agricultural science in England, which was pre-eminent in the later XVIIIth and early XIXth centuries, is today mere routine without science and is scarcely less backward than in China'. On the eve of the World War it was said to be a 'fact, that English agriculture was inferior to German both technically and economically'.[80]

The transformation of the forces of production in German agriculture had a profound and not entirely positive effect upon production relations and upon the nature of agrarian society. The expansion of the rootcrop area provided a vehicle for the permeation of the agricultural sector by a capitalist ethos to supersede the feudal, which involved the adoption of a more rational-scientific and profit-maximizing approach to farming. The result tends to cast doubt upon the widespread emphasis in modern historiography upon the contrast in the Imperial German elite, between a quasi-feudal class of Junker landowners and a thoroughly capitalist class of industrial entrepreneurs. Amongst the

[79] GROTKASS, *op. cit.*, p. 313; MOSEL, *op. cit.*, p. 51.

[80] BALLOD, *op. cit.*, p. 451; H. EBELING, *Wirtschaftliche Probleme bei dem deutsch-englischen Zuckerhandel* (Karlsruhe, 1914), p. 139.

latter, numerous examples exist, of which von Stumm, the steel magnate of the Saarland is perhaps the most outstanding, of a feudal-patriarchal approach to employer-employee relations and to the objectives of industrial production. Amongst the former, the sugar-beet and many of the potato-alcohol producing Junkers were far removed from the archetype of historical literature. They had made in fact a complete transition from the manorial lords of the XVIIIth century whose patrimonies had supported their provision of service to the Prussian state, to heads of 'agri-businesses' in which the most progressive capitalist farming was integrated with industrial enterprises based upon advanced technology and the principle of profit maximization.[81]

For the Junkers and for the ruling class of Germany as a whole, the negative aspect of the transformation of agricultural production was encapsulated in the breakdown of traditional employer-employee relations, and the growing dependence upon migratory and increasingly foreign labour that the process necessarily involved. For Max Weber: 'The introduction of the Poles is in the most real sense a weapon in the already anticipated class struggle'; 'The migration [of German agricultural workers to industry] is a latent strike, the Polish inflow the corresponding weapon against it'. In fact it has been claimed that the massive outflow of German agricultural labour from the eastern territories to the urban industrial west was as much a consequence of the expansion of the rootcrop area, with its demand for cheap and seasonal labour and its 'minimal requirements in respect of the quality of labour', as of the attraction of higher wages in industrial employment.[82]

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[81] SEIFFERT, *op. cit. passim.* See also W. KÜTTLER, 'Zu den Kriterien einer sozialen Typologie des Junkertums im System des deutschen Imperialismus vor 1917', *Zeitschrift für Geschichtswissenschaft*, Vol. XXVII, No. 8, 1979, pp. 721-735; A. ASCHER, 'Baron von Stumm, Advocate of Feudal Capitalism'. *Journal of Central European Affairs*, Vol. XXII, No. 3, 1962, pp. 271-285.

[82] M. WEBER, *op. cit.*, pp. 468-9; P. QUANTE, 'Die Bevölkerungsentwicklung der preussischen Ostprovinzen im 19. und 20. Jahrhundert', *Zeitschrift für Ostforschung*, Vol. VIII, 1959, p. 489.

The result not only threatened the dominant position of the Junkers in the power structure of the Empire, by weakening the extent and degree of its political and social control over a rural population. The process also threatened the territorial existence of the Empire in respect of the eastern territories, which could only be precariously maintained by quite determined efforts to maintain the seasonal rather than permanent residence of Polish agricultural workers in the east.