

Prof. John H. Munro
Department of Economics
University of Toronto

munro5@chass.utoronto.ca
john.munro@utoronto.ca
<http://www.economics.utoronto.ca/munro5/>

9 February 2011

ECONOMICS 303Y1

The Economic History of Modern Europe to 1914

Prof. John Munro

Lecture Topic No. 22:

V. THE RAPID INDUSTRIALIZATION OF GERMANY, 1815 - 1914

D. Germany: Peasant Emancipation and Agricultural Modernization to 1914

D. GERMANY: PEASANT EMANCIPATION AND AGRICULTURAL MODERNIZATION TO 1914

1. Introduction: Our Historical Objectives

a) **to examine to what extent agrarian changes in Germany (or what became Germany) during the 19th century both resembled and differed from the French model:**

- i.e., the model established by the French Revolutionary Land Reforms, 1790 - 1795
- and spread across the Rhine into Germany by the French Revolutionary and Napoleonic invasions, from 1792 to 1815.
- In essence, the German model of agrarian reform was to impose peasant emancipation from above in order to avoid peasant revolution from below.

b) **to ascertain to what extent these agrarian changes promoted German economic development:** both in terms of demographic growth and industrial growth – especially urban industrialization.

c) **and thus again to compare the similarities and differences in 19th century economic development:** to be found among the three countries so far examined: Great Britain, France, and Germany (with Russia yet to come).

2. A Preview: German Agriculture and Serfdom on the Eve of the French Revolution.

a) **German agriculture was (and subsequently remained) sharply divided in characteristics between eastern and western zones:** with the Elbe river [see map] marking the approximate boundary between the two zones.

b) **German agriculture west of the Elbe River:** here the agrarian structure was very similar to that of northern France, already analysed:

i) **manorialism and serfdom had long ago decayed in the West, as in France:** with only a very few scattered, non-commercialized areas still retaining any servile peasantry.

ii) **This region was largely one of very small peasant tenancies:**

(1) i.e., with peasants operating under traditional communal open-field systems, with small unconsolidated holdings, i.e., tenancies in the form of scattered plough strips in the open fields.

(2) In the West there were relatively few large landlord estates:

- the majority of landlords had leased out most of the demesne, or even the entire demesne (domain), to peasant tenants,
- much in the same way already seen in France.

c) **German agriculture east of the Elbe River:** large-estate agriculture, predominantly, though with many medium and small size farming units (as map on the screen will show).

i) **The Elbe river had long served as a boundary line:**

(1) marking the point of departure for the medieval Germanic conquests and settlements of the Slavic lands to the east:

(2) what the Germans called *Drang Nach Osten* ('Drive to the East') – with more ominous overtones in the 20th century, especially or course during World War II.

ii) **The term 'second serfdom' refers to the fact much earlier, during the High Middle Ages,**

(1) much of the peasantry in eastern Europe had remained free, until about the 14th century

- especially on the colonized lands that Germanic peoples had colonized from the late 12th century, at the invitation of Slavic landlords and the Church,
- while much of the peasantry in western Europe suffered the burdens of serfdom during the later medieval era, i.e., up to the 14th century;

(2) That relative freedom in the East had been a major force in attracting western colonists.

iii) **But then, while serfdom was slowly disappearing or eroding in later-medieval western Europe,** during the later 14th, 15th, and early 16th centuries -- virtually gone by early-modern times,

(1) the opposite was happening in Europe east of the Elbe: from the later 15th and especially the 16th and 17th centuries, most of these free peasant had been absorbed by large landlord estates,

(2) especially into and by the large estates of Prussian (East German) aristocratic landlords called *Junkers*.¹

(3) those peasants who worked these estates were subjected to a harsh serfdom, binding the peasants to their holdings and to the landlord, as chattels.

¹ From Answers.com and Wikipedia: 'Junkers (English pronunciation: [ˈjʊŋk ə]; German pronunciation: [ˈjʊŋ kɛ]) were the landed nobility of Prussia and Eastern Germany - lands which are often also called "Eastelbia" (Ostelbien in German - the land east of river Elbe). These families were mostly part of the German Uradel (very old feudal nobility) and carried on the colonization and Christianization of the northeastern European territories in the 11th, 12th and 13th century. "Junker" in German means "young lord", and is understood as country squire. It is probably derived from the German words Junger Herr, or Young Lord. As part of the nobility, many Junker families have particles such as "von" or "zu" before their family names. In the Middle Ages, a Junker was simply a lesser noble, often poor and politically insignificant. A good number of poor Junkers took up careers as soldiers and mercenaries. Over the centuries, they rose from disreputable captains of mercenary cutthroats to influential commanders and landowners in the 19th century. Being the bulwark of the Hohenzollern Empire, the Junkers controlled the military, leading in political influence and social status, and owning immense estates, especially in the north-eastern half of Germany (Brandenburg, Mecklenburg, Pommerania, East Prussia, Saxony, Silesia). Their political influence extended from the German Empire of 1871 to 1918 through the Weimar Republic of 1919–1933. It was said that Prussia ruled Germany, the Junkers ruled Prussia, and through it the Empire itself. They dominated all the higher civil offices and officer corps of the army and navy. Supporting monarchism and military traditions, they were often reactionary and protectionist; they were often anti-liberal, siding with the conservative monarchist forces during the Revolution of 1848. Their political interests were served by the German Conservative Party in the Reichstag and the extraparliamentary Agrarian League. This political class held tremendous power over the industrial classes and the government. When Chancellor Caprivi reduced the protective duties on imports of grain, these landed magnates demanded and obtained his dismissal; and in 1902, they brought about a restoration of such duties on foodstuffs as would keep the prices of their own products at a high level. The German statesman Otto von Bismarck was a noted Junker.'

(4) This serfdom meant

- compulsory and arbitrary labour duties on the domain (demesne) lands of their landlords,
- thus leaving them less time to work their own holdings.

iv) **The further east one travelled**, the worse became the serfdom.

v) **The historical significance of the Second Serfdom should be obvious:**

(1) the fact that eastern Europe was subjected to a growing spreading serfdom at the very time when the peasantry of western Europe was becoming freer and freer.

(2) that difference was an important factor in widening the economic gulf between east and west, especially in terms of agricultural productivity.

d) **The causes of this serfdom are enormously complex**, varying by region and time: not all of eastern Europe became engulfed in serfdom at the same time, and the process spread slowly and unevenly from the 15th to 17th centuries

i) **demographic model: For other parts of eastern Europe: the Evsey Domar model** ²

(1) According to this model, the next major period of the 'second serfdom', in other parts of eastern Europe, was during the demographic crises or stagnation of the 17th century,

- especially with the Thirty-Years War (1618-1648) and its aftermath,
- producing a scarcity of both labour and rent-paying tenants.

(2) Table 2 in the Appendix does indicate that eastern Europe's population

- fell from about 7.70 million in 1600 to 7.10 million in 1650,
- and had recovered to only 7.40 million by 1700
- over this period, this region's share of Europe's total population fell from 9.9% to 8.9% of the total

(2) Thus, with labour scarcity, an altered land:labour ratio, landlords sought to impose serfdom on their formerly free peasant tenants in order to prevent tenants from bidding down rents and also to prevent them, as agricultural workers, from bidding up wages.

(3) Thus peasants were subjected to arbitrary labour obligations, the *corvée* labour explained above, in the previous commercial model, i.e., when it was really involuntary.

(4) The second serfdom is thus seen as a manifestation of the so-called 'General Crisis of the 17th Century' (referred to in the first term):

- but this model has also only a limited applicability,

² Evsey D. Domar, 'The Causes of Slavery or Serfdom: A Hypothesis', *Journal of Economic History*, 30 (Mar. 1970), 18-32; Evsey Domar and Mark Machina, 'On the Profitability of Russian Serfdom', *Journal of Economic History*, 44 (December 1984), 919-55; Evsey D. Domar, *Capitalism, Socialism, and Serfdom* (Cambridge: Cambridge University Press, 1989). Collected essays. His model is similar to the one that the French economic historian, Marc Bloch, proposed to explain the original rise of serfdom in the late-Roman Empire: elevating the status of slaves and depressing the status of free peasants.

- because it cannot apply to regions where serfdom spread during population growth, and into regions with excess labour.
- indeed, the major spread of serfdom into eastern Germany and Poland accompanied a period of population growth – and one of inflation
- so let us consider an alternative model

ii) **The Commercial Model for Prussia and Poland:** in Germany east of the Elbe, especially those lands bordering on the Vistula river in Prussia and Poland, the favourite explanation is instead a commercial model:³

(1) The impact of European population growth and urbanization in the 16th and early 17th centuries:

- From 1600 to 1700, Europe's total population grew from 60.9 million to 77.9 million⁴ : an increase of 30.5%
- at the same time urbanization expanded much more rapidly, as indicated by the following table, showing a very large increase in the number of large towns in Europe

Year	Number of European Cities in the Indicated Population Range		
	50,000- 100,000	100,000 400,000	Over 400,000
		
1300	4	3 (or 4?)	0
1500	5	5	0
1650	14	12	3
1750	512	43	4

- most of the towns in western Europe could not be adequately fed from regional grain growing farm lands
- thus, there was a very considerable expansion in imports of relatively cheap grain from the Baltic lands, especially eastern Germany and Poland
- a demand to which the German Hanse and the Dutch seaborne merchants quickly responded.

³ Best expressed in: Eric Hobsbawm, 'The Crisis of the Seventeenth Century', *Past & Present*, nos. 5-6 (1954), reprinted in Trevor Aston, ed., *Crisis in Europe, 1550 - 1660* (London, 1965), especially pp. 20-21, 33-37.

⁴ See table 2 below (based on Jan de Vries)

- indeed, the Baltic grain trade became the mainstay of Dutch overseas commerce until the mid 17th century
- (2) That rapidly growing grain trade promoted, according to this model, the creation of vast grain estates using gangs of servile labour to produce grains – rye and barley:
- (3) hence the subjection of formerly free peasant villages to gain both their lands and cheap labour.
- (4) Servile labour is known as *corvée* labour:
- and can be seen as a form of rental payments, so that servile peasants, as a condition of their tenancies, are required to work on the lord's estate for one or more day's a week without wages, up to three days per week.
 - in some eastern European villages, peasants voluntarily subjected themselves to this form of rental payments rather than paying fixed shares of their harvest, when agricultural prices were rising.
 - so not all serfdom was necessarily involuntary;
 - and not all forms of serfdom are the same;
 - but as a rule of thumb genuine serfdom was involuntary and arbitrary in the nature of the exactions.
- (5) The shift from *Grundherrschaft* to *Gutsherrschaft*: are the terms given to this transition in the organization of feudal estates: a topic previously introduced in our history of French agriculture
- from *Grundherrschaft*: a system based on peasant land rents: i.e., in which peasant rentals provided the bulk of manorial incomes
 - to *Gutsherrschaft*: a manorial system from which the bulk of the manorial incomes were derived from the exploitation of the feudal demesne (domain) for commercial profit, using servile labour to work the demesne lands.
- (6) Fundamental question: what explains the feudal landlord mentality to make this transition, when population was growing, so that a change in the land:labour ratio should have made wage-labour relatively cheaper: thus why use servile labour?
- (7) Especially, if one assumes that free wage-labour would be more productive than servile labour.
- (8) **Inflation provides the answer:**⁵ as we noted previously, in discussing French agriculture

⁵ This part of the model will not be found in Hobsbawm, Brenner (see n. 5) or any other similar studies; it is my interpretation of the economics of such estates, based on my knowledge of East European demographic and monetary history. This model may be compared to the responses of many English manorial lords (or other landlords) during the 16th century Price Revolution (c.1520-1640) and again in the 18th century, in order to capture the rising economic rent on land (i.e., take it away from the customary peasant tenants): namely, Enclosures, by which these landlords evicted their customary peasant tenants, destroyed the communal Open Field system, amalgamated their tenancy strips into compact unified farms, which they then leased out to capitalist farmers, with leases short enough to allow landlords to recapture economic rents periodically, i.e., after the expiration of the leases. See ECO 301Y, lecture no. 17; and ECO 303Y, lecture no. 6, with this URL:
<http://www.economics.utoronto.ca/munro5/06agrarrev.pdf>

- This transition occurred during the inflationary Price Revolution era (ca. 1520 - c. 1650), exacerbated by regional coinage debasements (East Prussia, Poland, etc).
- but most feudal rents, for peasant tenancies, were fixed in money-of-account terms, and thus were not adjusted for inflation, so that they declined in real terms.
- consequently, under these circumstances, the peasant tenant and not the landlord would reap most of the rising economic on rent
- thus the shift from *Grundherrschaft* to *Gutsherrschaft* represents the landlord's motivation to recapture that economic rent, by exploiting his domain lands for commercial profit
- the landlord also gained by taking his peasant-tenancy rents in labour services, rather than in money rents (given that such rents are diminishing in real terms with inflation).

(9) A statistical illustration of the nature and importance of this East-Prussian and Polish *Grundherrschaft* model can be see in the following table for Brandenburg in 1601:

**Composition of the Capitalized Market Value
of the Stavenow Manorial Estates in Brandenburg (East Germany)
in 1601**

ASSETS	Value in Gulden	Percent Subtotal	Value in Gulden	Percent of Total
Manor: House and Demesne Farm Buildings			5,813	8.66%
Manorial Forest: Income from			15,552	23.16%
Demesne Production				
Grain Sales: income from	12,104	45.44%		
Livestock Production: income from sales	10,917	40.99%		
Fisheries and Gardens: income from	3,615	13.57%		
Sub-total of Demesne incomes	26,636	100.00%	26,636	39.66%
Manorial Jurisdictions and Properties				
Manorial Courts and Jurisdictional Fees	4,400	72.74%		
Manorial Mills: rental incomes	1,649	27.26%		
Sub-total of Manorial Jurisdictions	6,049	100.00%	6,049	9.01%
Peasant Rents: Servile Tenancies				
Labour Services	8,454	79.06%		
Rents in kind: in grain	1,375	12.86%		
Rents in cash: money payments	864	8.08%		
Sub-total of Peasant Rents	10,693	100.00%	10,693	15.92%
Foreign Peasants': Short Term Rents				

ASSETS	Value in Gulden	Percent Subtotal	Value in Gulden	Percent of Total
Labour Services	1,609	66.68%		
Rents in kind: in grain	804	33.32%		
Sub-total of 'Foreign Peasants' Rents	2,413	100.00%	2,413	3.59%
TOTAL VALUES			67,156	100.00%

Source: William Hagen, 'How Mighty the Junkers? Peasant Rents and Seigneurial Profits in Sixteenth-Century Brandenburg', *Past & Present*, no. 108 (August 1985), p. 100.

(9) **While this thesis may appear to be apt or useful for this region, for parts of Prussia and Poland (Vistula river valley)**, in particular, it hardly explains the spreading stain of serfdom into other areas of eastern Europe, where arable agriculture did not produce any significant export commodities;

(10) Even in many parts of grain producing Poland it does not work: that some areas became enserfed (or more fully enserfed) after the decline of the Baltic grain trade.

iii) **Institutional Model: Landlords vs. the prince and peasants (the Jerome Blum model):⁶**

The only common feature of the Second Serfdom concerns the political and economic powers of the landlords, feudal and especially Junker landlords, who enserfed their tenants:

(1) The absence or weakness of peasant village organizations or other cohesive peasant communities able to resist the powers of aggressive feudal landlords.

(2) The absence or weakness of market structures, especially urban based market structures, to allow peasants to engage in commercialized agriculture, to satisfy landlords with cash rents.

(3) Above all the absence or weakness of centralized monarchical power, as in western Europe, to resist this expansion of feudal landlord power – which meant military power.

(4) In many cases, the kings or princes of eastern Europe made a tacit or explicit compact with the feudal landlords:

- in return for the political support of these feudal magnates, and for their support for royal or princely justice and police powers in the territorial state (kingdom, duchy, etc.),
- the king or prince would not interfere with the jurisdiction of the feudal magnates within their estates, i.e., the jurisdiction over their peasantry.

⁶ Jerome Blum, 'The Rise of Serfdom in Eastern Europe', *American Historical Review*, 62 (July 1957), 807-36; Jerome Blum, *The End of the Old Order in Rural Europe* (Princeton, 1978). See also a further elaboration of this thesis in: Robert Brenner, 'Agrarian Class Structure and Economic Development in Pre-Industrial Europe', *Past and Present*, no. 70 (February 1976), pp. 30-74, reprinted in T. H. Aston and C. H. E. Philpin, eds., *The Brenner Debate: Agrarian Class Structure and Economic Development in Pre-Industrial Europe* (Cambridge, 1985), pp. 10 - 63.

(5) That same compact had once been true in medieval England, as I had mentioned before;

- but the compact broke down from the later 14th century, and serfdom then declined,
- as the crown (royal power) asserted its authority over feudal powers and courts within England (also in France)

(6) Why did landlords seek to enserf and thus oppress their peasant tenants?

- please understand clearly that serfdom does mean oppression: the denial of liberty and other basic human rights
- it does mean exploitation with arbitrary exactions (e.g., labour services), if not checked by feudal-manorial customs ('customary law')
- Thus: do landlords seek the power to oppress and enserf peasants because that is what landlords were expected to do: for the love of power?

(6) In my view, this Blum-Brenner thesis on class relationships and relative powers of landlords and tenants makes sense only if we explain landlord motivations, in switching from *Grundsherrschaft* to *Gutsherrschaft*, in the fashion so described

iv) **In summary:** The process of this so-called Second Serfdom was a slow, piecemeal one,

(1) taking place for many complex reasons (explored in greater depth in my Eco. 301Y course),⁷

(2) extending over about two centuries, from the later 15th to later 17th centuries,

(3) reaching its peak in the 18th century,

(4) in Mecklenburg, Brandenburg, Prussia, Poland, Lithuania, and Russia (and also in Bohemia-Moravia, Hungary, Rumania, etc.).

(5) **In the regions of East Prussia and Poland:** along the Vistula River valley in particular, large centrally-run estates were organized for the production and export of grain (rye).

3. German Peasant Emancipation in the 19th Century:

a) **German 'peasant emancipation' during the 19th century was essentially emancipation from above,**

i) **i.e., by the state,** to avoid emancipation from below, by peasant revolution,

ii) **a persistent fear of peasant revolt:** created by the forces of the French Revolution and Napoleonic occupation of western Germany.

iii) **Indeed the French Revolution and the revolutionary land reforms set the model:** for not only Germany, but much of the rest of Europe as well (including Russia).

iv) **we must carefully observe both the similarities with and the differences:** from the French experience of peasant emancipation after the French Revolution

⁷ See ECO 301Y lecture no 7: <http://www.economics.utoronto.ca/munro5/07agrmd1.pdf>

b) Peasant Emancipation in Western Germany (outside of Prussia):

i) In those Rhineland territories occupied by Napoleon:

- (1) the French military occupiers abolished all feudal and servile ties outright,
- (2) giving the German peasantry the same rights enjoyed by French peasants.

ii) **Kingdom of Bavaria:** succumbing to French pressure, abolished serfdom entirely in 1803.

iii) Kingdoms of Saxony and Hanover:

- (1) resisted, however, any changes until a peasant revolt in 1830 forced these kingdoms to begin dismantling serfdom, along the same lines.
- (2) 1834: Saxony also established land banks to assist peasantry in buying their freedom.

c) The Kingdom of Prussia (the largest in Germany):

i) The Stein-Hardenberg reforms:

- (1) In response to the consequences of French Revolution, Napoleonic conquests in the west, and peasant emancipation there,
- (2) the Prussian government began dismantling serfdom with a series of edicts between 1805 and 1821, known as the Stein-Hardenberg reforms.

ii) Basic provisions in summary (to 1821):

(1) servile peasants who owed labour services but who also owned a plough team:

- could purchase both their personal freedom and some of their land by handing over a portion of their tenancies to the landlord.
- If they held their lands by hereditary tenure, they had to surrender only one-third;
- If not, if they had no hereditary lands, they had to cede one half of their tenures.

(2) **small servile peasants, serfs without plough teams:** were originally excluded from these decrees to maintain a labour supply for the Junkers.

iii) This, therefore, was emancipation from above according to the philosophy of economic liberalism: in effect,

- (1) it really meant the loss of any feudal protection for the peasants,
- (2) while protecting the property rights of the landlords, compensating them for any losses.

iv) Prussian Emancipation Law of 1850: in response to the abortive (but European wide) revolutions of 1848, the Prussian government hastily completed the process of peasant emancipation to give eastern peasants the same rights as those enjoyed in the west:

- (1) all remaining servile obligations and dues, all feudal ties, were henceforth abolished;
- (2) and all peasant tenures were declared freehold.
- (3) all economic charges on land tenures were made fully redeemable in cash, which could be paid annually in form of increased rents.

(4) it was no longer necessary for any peasant to surrender any of his holdings to obtain freedom and title to his land.

v) **The Rentenbank, an agricultural land-bank:** Following the Saxon model, the Prussian government set up a land bank to assist the peasants in buying their lands.

4. Economic and Social Consequences of Peasant Emancipation:

In general, the consequences were a perpetuation of those ancient east-west divisions across the Elbe, but under new conditions that favoured the Junker landlords in the east and the peasantry in the West.

a) **The Lands East of the Elbe River:**

i) **the chief gainers, to repeat, were the Junker landlords of East Elbia:⁸**

(1) but certainly not their serfs, because the pre-1850 emancipation laws proved so costly to the servile peasantry,

(2) Before 1850, serfs had been obliged to give up from a third to half of their lands to the landlord, depending upon their status, to win their freedom.

ii) **Many peasants who did yield their lands under these circumstances found their remaining holdings in the Common Fields too small to be economically viable:** and so many of them sold their lands entirely to the Junker landlords.

German Agriculture in the early 20th century:

1907 (But in terms of post 1919-frontiers)

Category of Land holdings: measured in hectares	Percentages of the Total Arable Area per Category in hectares		
	East Elbia*	Rest of Germany	All of Germany
Under 5 ha.	8.7%	21.0%	16.2%
5 - 20 ha.	21.3%	41.0%	33.4%

⁸ The most recent study is by a Professor Emeritus of our Department of Economics: Scott M. Eddie, *Landownership in Eastern Germany Before the Great War* (Oxford and New York: Oxford University Press, 2008).

Category of Land holdings: measured in hectares	Percentages of the Total Arable Area per Category in hectares		
	East Elbia*	Rest of Germany	All of Germany
20 - 100 ha.	29.5%	29.9%	29.8%
Over 100 ha.	40.5%	8.1%	20.6%
Over 20 ha.	70.0%	38.0%	50.4%

* **East Elbia:** Posen and West Prussia, East Prussia, Pomerania, Brandenburg-Berlin, Silesia, Mecklenburg.

iii) **Consequently by all such means, the eastern Junker landlords acquired about a million hectares** (2.5 million acres), of peasant lands by 1860s.

iv) **The Junkers also gained economically by having their estates completely separated from peasant holdings:**⁹

(1) Note: when, in earlier times, landlords had leased out portions of their demesnes to peasant, they often did so in the traditional Common Field form of scattered plough strips, intermingled with the demesne strips that the landlord had retained

(2) This curious system, also found in the West (and also in England), had the advantage for the landlord of having the peasants plough these demesne lands for the landlord (virtually free labour)

(3) Now, after peasant emancipation, the manorial lords were thus better able to enclose their own lands to create compact often vast farms: i.e., enclosure without concern for peasant property rights.

(4) With enclosure and untrammelled completely separated property rights, Junker landowners could now use their lands more effectively as collateral to borrow money through mortgages.

v) **Many and finally most of those Junkers who enclosed and amalgamated their estates,** and similarly also the larger peasant farmers who similarly engaged in enclosures, quickly modernized their farming techniques.

⁹ Note that especially from later medieval and/or early modern times, many landlords had allowed some or all of their domain lands to become mixed with the peasant tenancies in the great open fields, especially after leasing some domain lands to peasants. With increased labour exactions from servile peasant tenants, to work domain lands, that process was facilitated if domain strips to be cultivated were close to or adjacent to the strips of the peasants supplying such labour.

(1) They replaced the traditional three field systems with convertible husbandry and multiple course crop rotations, thus greatly reducing the fallow.

(2) Subsequently as we shall see they also led the way in applying chemical fertilizers and steam-powered farm machinery.

vi) **The necessary labour force to work these large estates or commercial farms came from the growing number of dispossessed landless peasants:** in sharp contrast to France, eastern Germany had a surplus rather than a scarcity of agricultural peasant labour.

b) **The Lands West of the Elbe River:**

i) **Here the land distribution was much more akin to that found in northern France after the Revolution:** i.e., strongly skewed to small-scale peasant farming.

ii) **In south-west Germany, especially, most of the land was distributed in the form of very small scale peasant holdings:** smaller indeed than was typical in France.

iii) **In central Germany, however, just west of the Elbe:** we find a predominance of medium sized holdings (smaller nobility, gentry, richer peasants).

iv) **From the 1850s the spread of the railways,** as in France, greatly promoted the spread of enclosures, by promoting the commercialization of agriculture, and by reducing farming costs.

v) **furthermore, the development of coal mining was also important:** in reducing the need for wood fuel and thus permitting much forest land to be cleared and enclosed.

vi) **Again, as was the case in France, enclosure in western Germany did not generally lead to large-scale estates:** again enclosure was more in the form of reallocation of peasant strips into compact but small farms.

5. Technical Advances in German Agriculture

a) **Productivity Gains:**

i) **Of all European countries (certainly continental countries) after 1850,** Germany -- central and eastern Germany -- made far and away the greatest technical advances in agriculture, achieved by far the greatest productivity gains.

ii) **Those gains were all the more impressive,** when we consider the relatively poor soils and harsh climate involved for much of German agriculture, compared to northern France and England.

b) **The initial phase of productivity advances: the cultivation of leguminous crops:**

i) **Leguminous or nitrogen fixing crops:**

(1) were planted as fodder crops, in form of multiple course crop rotations,

- to permit sharp reductions in the amount of fallow,

- or to eliminate the need for fallow lands.

(2) Recall from previous lectures:

- that the root systems of such crops attracted parasitic insects and other organisms that absorbed nitrogen from the atmosphere
- and thus created nitrogen based compounds that they deposited in the soil by their death and decay (symbiotic fixation: nitrification).¹⁰

(3) Nitrogen-fixation was also produced:

- from the decay and deposits of the root systems themselves, and plant nodules, and stubble remaining after harvest,
- and then ploughed into the soil, as ‘green manuring’.

(4) Note again that nitrogen (N) is the single most important fertilizing chemical, followed by potassium (K).

ii) **clover, alfalfa (lucerne), and sainfoin (plant of pea family) were the most important in nitrogen fixing-properties:** and far more powerful than the traditional legumes (or pulses: chiefly beans, peas, vetches, lupins):

Nitrogen Fixation from Legume Residues: kilograms per hectare (= 2.47 acres)

Legume	Macro-organic	Unmeasured	Total Nitrogen	Ratio to Pulses
Pulses (peas, beans, vetches)	30.00		30.00	1.000
Clover	75.00	25.00	100.00	3.330
Sainfoin	112.50	57.50	170.00	5.667
Alfalfa (Lucerne)	150.00	75.00	225.00	7.500

Source: See Patrick Chorley, ‘The Agricultural Revolution in Northern Europe, 1750 - 1880’, *Economic History Review*, 2nd ser. 34 (Feb. 1981), 75-77.

iii) **they were doubly fertilizing:**

(1) From Nitrogen fixation in the soil: from the decay of parasitic bacteria, as just explained, who fed on the root systems of these legumes

(2) From feeding these leguminous crops to livestock: who then produced manure, to be dug into the soils.

iv) **I must also stress that, for increasing soil fertility, the crops themselves were more important: 60%**

¹⁰ From Answers.com: ‘Nitrification: To oxidize (an ammonia compound) into nitric acid, nitrous acid, or any nitrate or nitrite, especially by the action of nitrobacteria; to treat or combine with nitrogen or compounds containing nitrogen.’ From the *Medical Dictionary*: ‘The oxidation of an ammonia compound into nitric acid, nitrous acid, or any nitrate or nitrite, especially by the action of bacteria; the treatment or combination of a substance with nitrogen or compounds containing nitrogen.’

from nitrogen vs. 40% from livestock manure.

v) **The maximum impact was reached (according to Chorley) about 1880,**

(1) when cultivation of leguminous crops was permitting grain yields of about 12 to 15 quintals per hectare (1 quintal = 100 kg; 1 hectare = 2.47 acres)

(2) thereafter chemical fertilizers became more important (though not that much more important).

b) **Second phase: cultivation of root crops in multiple rotations:** especially sugar beets and potatoes (across northern Europe) from 1840s.

i) **Very dramatic increase in their cultivation from 1870s to 1914:** (See table on screen).

German Agriculture

Annual Output of Certain Crops, 1871 - 1913, in Thousands of Metric Tons

Decade	Sugar Beets	Potatoes	Wheat	Rye	Barley	Oats
1875-84	5,810	24,840	2,552	6,673	2,632	4,823
1885-94	9,510	30,460	3,045	7,237	2,666	5,587
1895-04	13,380	39,100	3,491	8,831	2,959	6,979
1905-14	16,090	45,790	3,956	10,665	3,244	8,382

Source: Alan Milward and S.B. Saul, *Development of the Economies of Continental Europe, 1850 - 1914* (London, 1977, p. 54: Table 5.

(1) **sugar beets:** from 5.810 million tons to 16.090 million tons (+176%).

(2) **potatoes:** from 24.84 million tons to 45.79 million tons (+84.4%).

ii) **cultivation of these crops, while not in themselves nitrogen-fixing, did improve productivity and grain outputs in several ways:**

(1) they rested the soil by taking out far fewer nutrients.

(2) they required far more intensive soil cultivation (hoeing and aeration) thus improving soil for the grain

crops that followed.

(3) they promoted the use of chemical fertilizers.

iii) **they also provided an important source of fodder for livestock:** potatoes or beet tops fed directly to livestock; and the waste products from both after being processed as industrial products.

iv) **industrial impact of these root crops:**

(1) **sugar-refining industries:** beet-sugar displaced much cane sugar.

- The Kingdom of Saxony was the major centre, producing about 30% of Germany's sugar-beets;
- and Germany itself became a major producer of beet-sugar, accounting for 30% of world production.
- By 1900, Germany had over 400 factories processing 2 million metric tons of sugar a year.

(2) **distilling industries from potatoes:** to produce vodka, schnapps.

(3) **Potato cultivation:** serviced over 5,000 distilleries in 1900.

c) **Third phase: Chemical fertilizers**

i) **Of all countries, Germany made the greatest progress in applying chemistry to scientific agriculture,** beginning with Justus von Liebig's seminal book on *Chemistry and Its Application to Agriculture*, published in 1840. [Discussed earlier in the topic on British agriculture]

ii) **German leadership in chemical agriculture was based upon a combination of:**

(1) decisive superiority in scientific educational facilities, especially in having a university system in which science played the dominant role.

(2) world leadership in a new coal-based chemicals industry from 1870s.

(3) large supply of chemical raw materials:

- in form of coal (for nitrogen compounds) and potash (K_2O), supplying potassium.
- one important chemical fertilizer, superphosphate, was a byproduct of the German steel industry.

iii) **See table on the screen for rapid growth in applying chemical fertilizers in the later 19th and 20th centuries.**

German Agriculture:

**Average Annual Application of Chemical Fertilizers
Kilograms per Hectare of Agricultural Land, 1878/80 - 1913/14**

Period	Nitrogen	Superphosphate (N)	Potash (P_2O)(K_2O)
1878-80	0.7	1.6	0.8

Period	Nitrogen	Superphosphate (N)	Potash (P ₂ O)(K ₂ O)
1898-00	2.2	10.3	3.1
1913-14	6.4	18.9	16.7

1 hectare = 2.47 acres

Source: J.A. Perkins, 'The Agricultural Revolution in Germany, 1850 - 1914', *Journal of European Economic History*, 10 (Spring 1981), p. 85.

Note that German farmers on average used three times as much chemical fertilizers as did French farmers.

d) **Fourth and final phase: mechanization of German agriculture:** especially from the 1880s

i) **mechanization with steam powered machinery:**

(1) with steam-powered ploughs, threshers, reapers, etc.,

(2) on large central and East German estates

(3) livestock in the form of draught animals still remained important, as one of the tables in the Appendix demonstrates: for the century 1815 to 1913

- with a 57.1% increase in the number of livestock employed (in terms of equivalent number of horses)
- and 200.0% (tripling) in the application of horsepower energy

(4) We do not know, however, how much in relative terms livestock usage was reduced (relative to total agricultural output) or replaced by mechanization.

ii) **relationship between mechanization and application of chemical fertilizers:**

(1) To the extent that steam powered machinery displaced draught (draft) animals – horses, oxen, mule, etc. – that would have led to a relative reduction in the production of fodder crops

(2) To the extent that:

- fodder crops had been leguminous (nitrogen fixing)
- and that livestock fed from such crops had supplied manure for arable lands
- there would have been a dual reduction in these fertilizing agents

(3) Therefore the deficiencies in fertilizing agents provided by the combination of fodder crops and livestock manure had to be remedied: and chiefly by increased applications of chemical fertilizers

(4) Refer to the discussion of this inter-related problem – of mechanization and chemical fertilizers – in our

previous discussion of change in 19th-century British agriculture (lecture no. 15).

e) **Consequences for Agricultural Productivity:** As a result of all these advances in crop rotations and fertilizers, in the mechanization of agriculture itself:

i) **the amount of land lying fallow in Germany fell by over 50% from 1870s to 1900;** and almost no land was left fallow in areas devoted to root crops with chemical fertilizers.

ii) **The statistical table below shows the very rapid increases in agricultural output and productivity after 1870s:**

**Output of Principal Grain Crops of Selected European countries,
in millions of quintals, in decennial averages, 1871-90 to 1905-14**

Decade	Great Britain	France	Germany	Russia
1781-90	35.0	85.3		
1791 - 1800	43.0	94.5		268.6
1815-24	49.5	104.0		n.a.
1825-34	n.a.	116.3		n.a.
1835-44	n.a.	131.4		310.1
1845-54	64.0	146.6	122.6	363.3
1855-64	68.0	158.5	153.7	381.2
1865-74	70.0	160.1	204.8	410.1

Decade	Great Britain	France	Germany	Russia
1875-84	n.a.	161.8	248.4	451.0
1885-94	56.9	160.1	304.6	515.4
1895-1904	52.5	172.1	391.0	479.3
1905-14	51.7	171.9	457.9	543.1

1 quintal = 100 kilograms = 0.10 metric ton = 220.46 lb.

Source: Carlo Cipolla, ed., *Fontana Economic History of Europe*, Vol. IV:2, pp. 752-53.

(1) **in grain production:** despite the expansion in other agricultural sectors, and thus a proportional contraction in land area devoted to grains, these crops (rye, wheat, barley) still remained the largest single component of German agriculture.

(2) **As the table shows,** German grain output achieved a very dramatic increase from 1850s to 1914:

- a 3.7 fold increase (270%)
- compared to a mere 17% increase for French grain output during the same period.

(3) Note that Germany's aggregate grain production was well behind the French in the 1840s, but it

- ended up being 2.67 times greater, in 1914
- and almost 9 times greater than the British grain output
- but of course Britain had deliberately contracted its grain-growing sector

(4) Up to the 1870s, most of this dramatic increase in grain output came from expansion of the arable and reduction of the fallow.

(5) In Prussia alone, the arable expanded 25% between 1815 and 1870: from 5.2 million to 6.5 million acres, or 2.65 million hectares.

iii) **Productivity Grains:** From the 1870s to 1910, the expansion came essentially from rising soil productivity with nitrogen-fixing crops and chemical fertilizers.

(1) Estimated that in this period German grain yields almost doubled: from 18.7 quintals to 32.9 quintals per

hectare [quintal = 100 kg.]

(2) Comparative grain yields are shown on tables on the screen; and again you should note how much higher they are than the French yields (though one table necessarily combines the yields and outputs for Germany, Belgium, and France combined, c. 1880).

Crop Yields in France, Britain, and Germany, 1906-10
Kilograms of Output per Hectare of Land: Five-Year Means

(1 hectare = 10,000 m² = 2.47 acres)

Crop	France	Britain	Germany
Wheat	135	221	201
Rye	106	182	170
Barley	130	196	196
Oats	126	189	197
Potatoes	86	138	136

Source: J.A. Perkins, 'The Agricultural Revolution in Germany, 1850-1914', *Journal of European Economic History*, 10 (Spring 1981), p. 115.

(3) Admittedly, the British grain yields are higher: but remember that British grain production and arable farming had shrunk, in face of cheap foreign imports under free trade, to a very small sector that had to be productive to survive, on the very best and most fertile grain lands.

(4) In Germany, however, as in France, high protective tariffs from 1879 kept much more grain land in production, sheltered from cheap overseas grains.

(5) Remember also that German soils and climate were much less favourable than those in Britain and northern France.

iv) **Also, note from the statistics on food production:** the very dramatic increases in sugar beet and potato cultivation from the 1870s to 1914.

v) **Finally, from the table previously shown for French agriculture,** calculating agricultural productivity in terms of millions of calories produced per year by a male farm worker, you will see (from Paul Bairoch's estimates) that overall German productivity in agriculture by 1910 was higher than that for any European country, and was exceeded only by the US.

Indices of European and American Agricultural Productivity

from 1810 to 1910

Annual net output per agricultural worker (male)

measured in million of calories

COUNTRY	1810	1840	1860	1880	1900	1910
Britain	14.0	17.5	20.0	23.5	22.5	23.5
France	7.0	11.5	14.5	14.0	15.5	17.0
Germany		7.5	10.5	14.5	22.0	25.0
Russia		7.0	7.5	7.0	9.0	11.0
USA		21.5	22.5	29.0	31.0	42.0

Source: Paul Bairoch, 'Niveaux de développement économique de 1810 à 1910', *Annales: Économies, sociétés, civilisations*, 20 (1965), 1096, Table 1.

vi) **Labour Productivity in German agriculture:** also made impressive gains from 1815 to 1914: and far more so than in any other European country

Labour Productivity in European Agriculture in the 19th century in terms of the value of the British pound sterling in 1910

Year	England/ Wales	France	Germany	Netherlands
------	-------------------	--------	---------	-------------

1815	46	20	9	36
1840		22	16	37
1850	65		19	37
1860		36	26	37
1870	71	43	28	40
1880	79	37	35	38
1890	94	39	42	36
1900	108	34	49	38
1913	110	45	55	42
Percent Change 1815 to 1913	139.13%	125.00%	511.11%	16.67%

Source:

Astrid Kander and Paul Warde, 'Energy Availability from Livestock and Agricultural Productivity in Europe, 1815 - 1913: A New Comparison', *Economic History Review*, 2nd ser., 64:1 (February 2011), Table 1a, p. 2.

6. Contributions of German Agriculture to German Industrialization

a) Population and the Food Supply:

i) as can be seen in next table on screen, concerning population in major 19th century countries:

The Populations of Selected European Countries

in millions, in decennial intervals, 1800-1910

Year	Great Britain	Belgium	France	Germany	Russia
1800	10.7	3.1	27.3	n.a.	35.5
1810	12.0	n.a.	n.a.	n.a.	n.a.
1820	14.1	n.a.	30.5	25.0	48.6

Year	Great Britain	Belgium	France	Germany	Russia
1830	16.3	4.1	32.6	28.2	56.1
1840	18.5	4.1	34.2	31.4	62.4
1850	20.8	4.3	35.8	34.0	68.5
1860	23.2	4.5	37.4	36.2	74.1
1870	26.0	4.8	36.1 ^a	40.8 ^b	84.5
1880	29.7	5.3	37.7	45.2	97.7
1890	33.0	6.1	38.3	49.4	117.8
1900	37.0	6.6	39.0	56.4	132.9
1910	40.9	7.4	39.6	64.9	160.7

^a Excluding Alsace-Lorraine.

^b Including Alsace-Lorraine.

Sources: B.R. Mitchell and P. Deane, *Abstract of British Historical Statistics* (Cambridge, 1962), pp. 8-10; Carlo Cipolla, ed., *Fontana Economic History of Europe*, Vol. IV:2, pp. 747-48.

(1) Germany's population grew very rapidly in the course of the 19th century, by 160%, i.e., a 2.6 fold increase;

(2) and thus Germany grew three times faster than did France, whose population increased only by 50%.

ii) **Obviously that greatly expanded agricultural output**, especially of grains, at least facilitated that rapid population growth;

iii) **indeed for most of the 19th century**, German grain production did rise faster than the domestic population.

iv) **Certainly one may also argue that this increased agricultural production**, with a wide variety of crops, also improved nutrition and living standards Germany.

b) The Provision of an Industrial Labour Force:

i) **as in Britain, the combination of agrarian and demographic changes were very important in supplying a large and elastic industrial labour force for Germany industry:**

(1) labour drawn from both a dispossessed, landless peasantry and a growing population, a population increasingly freed from or separated from the land.

(2) Nevertheless, as in Britain, those agrarian and labour force changes

- did not occur immediately and directly,
- because much of the dispossessed peasantry initially served as an agricultural labour force (ie. as an agrarian proletariat) on large estates,
- possibly involving a considerable disguised unemployment.

ii) **Labour Displacement:** From the 1870s, however, with much more extensive mechanization, and productivity increases from chemical agriculture, much of that excess labour was dislodged and was forced to leave the land.

iii) **Migration to Industrial Areas:** By 1910, over two million peasants had migrated from agrarian areas of East Prussia to settle in chiefly industrial areas: around Berlin, Saxony, and the Ruhr valley in particular.

iv) **Results in Agriculture:** From 1860 to 1910, the percentage of the total population engaged in German agriculture fell from about 60% (21.7 million) to just 32.0% (20.8 million), which meant a sharp relative fall and a slight absolute reduction in numbers as well.

v) **Urbanization:** Finally, note that the percentage of the population living in industrial cities rose

(1) from just 20% in 1800 to 40% by 1880 and

(2) then rose to over 60% by 1910, when Germany had clearly become an industrialized state,

(3) and one essentially based on urban industrialization – far more so than in France or Russia, if still less so than in Great Britain.

Table 1. Composition of the Capitalized Market Value of the Stavenow Manorial Estates in Brandenburg (East Germany) in 1601

ASSETS	Value in Gulden	Percent Subtotal	Value in Gulden	Percent of Total
Manor: House and Demesne Farm Buildings			5,813	8.66%
Manorial Forest: Income from Demesne Production			15,552	23.16%
Grain Sales: income from	12,104	45.44%		
Livestock Production: income from sales	10,917	40.99%		
Fisheries and Gardens: income from	3,615	13.57%		
Sub-total of Demesne incomes	26,636	100.00%	26,636	39.66%
Manorial Jurisdictions and Properties				
Manorial Courts and Jurisdictional Fees	4,400	72.74%		
Manorial Mills: rental incomes	1,649	27.26%		
Sub-total of Manorial Jurisdictions	6,049	100.00%	6,049	9.01%
Peasant Rents: Servile Tenancies				
Labour Services	8,454	79.06%		
Rents in kind: in grain	1,375	12.86%		
Rents in cash: money payments	864	8.08%		
Sub-total of Peasant Rents	10,693	100.00%	10,693	15.92%
Foreign Peasants': Short Term Rents				
Labour Services	1,609	66.68%		
Rents in kind: in grain	804	33.32%		
Sub-total of 'Foreign Peasants' Rents	2,413	100.00%	2,413	3.59%
TOTAL VALUES			67,156	100.00%

Source: William Hagen, 'How Mighty the Junkers? Peasant Rents and Seigneurial Profits in Sixteenth-Century Brandenburg', *Past & Present*, no. 108 (August 1985), p. 100.

**Table 2. The Populations of Europe, by Regions, 1500 - 1800
in millions**

Region	1500	1550	1600	1650	1700	1750	1800
North West	7.6	9.5	11.0	14.3	15.1	17.4	25.3
NW % of Europe	12.5%	13.6%	14.1%	19.2%	18.1%	17.9%	20.7%
Central Europe	29.0	33.8	36.9	33.5	38.2	43.8	53.5
Cent % of Europe	47.6%	48.3%	47.4%	45.0%	45.7%	45.1%	43.8%
Mediterranean	18.3	20.0	22.3	19.6	22.8	26.5	31.2
Med % of Europe	30.0%	28.6%	28.6%	26.3%	27.3%	27.3%	25.5%
Eastern Europe	6.0	6.6	7.7	7.1	7.4	9.4	12.2
Eastern % of Europe	9.9%	9.5%	9.9%	9.5%	8.9%	9.7%	10.0%
TOTAL	60.9	69.9	77.9	74.5	83.5	97.1	122.2

Source: Jan De Vries, 'Population', in T.A. Brady, H.A. Oberman, and J.D. Tracy, eds., *Handbook of European History, 1400-1600*, Vol. I: *Structures and Assertions* (Leiden, 1994), p. 13.

**Table 3. French and German Agriculture in the 19th century
Distribution of Farm Lands**

**Table 3a. French Agriculture in the 19th century
Distribution of Farm Lands by the 1881 Survey**

Category	Number of Farms by Area	Percentage of Total Farms	Area in Hectares (2.47 acres)	Per Cent of Total Area
Under 5 hectares	1,866,000	53.3%	5,600,000	11.5%
5 - 20 hectares	1,200,000	34.2%	12,300,000	25.3%
20 - 40 hectares	296,000	8.5%	8,400,000	17.3%
Over 40 hectares (100 acres)	142,000	4.1%	22,300,000	45.9%
TOTAL	3,504,000	100.0%	48,600,000	100.0%
Over 20 hectares	438,000	12.5%	30,700,000	63.2%

Table 3b. German Agriculture in the early 20th century:

1907 (But in terms of post 1919-frontiers)

Category	Percentages of the Total Arable Area per Category		
	East Elbia*	Rest of Germany	All Germany
in hectares			
Under 5 ha.	8.7%	21.0%	16.2%
5 - 20 ha.	21.3%	41.0%	33.4%
20 - 100 ha.	29.5%	29.9%	29.8%
Over 100 ha.	40.5%	8.1%	20.6%
(250 acres)			
Over 20 ha.	70.0%	38.0%	50.4%

* **East Elbia:** Posen and West Prussia, East Prussia, Pomerania, Brandenburg-Berlin, Silesia, Mecklenburg.

**Table 4. Output of Principal Grain Crops of Selected European countries,
in millions of quintals, in decennial averages, 1871-90 to 1905-14**

Decade	Great Britain	France	Germany	Russia
1781-90	35.0	85.3		
1805-14	43.0	94.5		268.6
1815-24	49.5	104.0		n.a.
1825-34	n.a.	116.3		n.a.
1835-44	n.a.	131.4		310.1
1845-54	64.0	146.6	122.6	363.3
1855-64	68.0	158.5	153.7	381.2
1865-74	70.0	160.1	204.8	410.1
1875-84	n.a.	161.8	248.4	451.0
1885-94	56.9	160.1	304.6	515.4
1895-1904	52.5	172.1	391.0	479.3
1905-14	51.7	171.9	457.9	543.1

1 quintal = 100 kilograms = 0.10 metric ton = 220.46 lb.

Source: Carlo Cipolla, ed., *Fontana Economic History of Europe*, Vol. IV:2, pp. 752-53.

**Table 5: Nitrogen Fixation from Legume Residues:
kilograms per hectare (= 2.47 acres)**

Legume	Macro-organic	Unmeasured	Total Nitrogen	Ratio to Pulses
Pulses (peas, beans, vetches)	30.00		30.00	1.000
Clover	75.00	25.00	100.00	3.330
Sainfoin	112.50	57.50	170.00	5.667
Alfalfa (Lucerne)	150.00	75.00	225.00	7.500

Source: Patrick Chorley, 'The Agricultural Revolution in Northern Europe, 1750 - 1880', *Economic History Review*, 2nd ser. 34 (Feb. 1981), 75-77.

Table 6.**Crop Yields in France, Britain, and Germany, 1906-10****Kilograms of Output per Hectare of Land: Five-Year Means****(1 hectare = 2.47 acres)**

Crop	France	Britain	Germany
Wheat	135	221	201
Rye	106	182	170
Barley	130	196	196
Oats	126	189	197
Potatoes	86	138	136

Source: J.A. Perkins, 'The Agricultural Revolution in Germany, 1850-1914', *Journal of European Economic History*, 10 (Spring 1981), p. 115.

Table 7.

Wheat-tons per Labour-unit in Agriculture in Selected Countries: France, Britain, Germany, and the U. S. in 1880 and 1930

Country	1880	1930
France	7.4	13.2
Great Britain	16.2	20.1
Germany	7.9	16.0
United States	13.0	22.5

**Table 8. Indices of European and American Agricultural Productivity
from 1810 to 1910**

**Annual net output per agricultural worker (male)
measured in million of calories**

COUNTRY	1810	1840	1860	1880	1900	1910
Britain	14	17.5	20	23.5	22.5	23.5
France	7	11.5	14.5	14	15.5	17
Germany		7.5	10.5	14.5	22	25
Russia		7	7.5	7	9	11
USA		21.5	22.5	29	31	42

Source: Paul Bairoch, 'Niveaux de développement économique de 1810 à 1910', *Annales: Économies, sociétés, civilisations*, 20 (1965), 1096, Table 1.

Table 9.**German Agriculture****Annual Output of Certain Crops, 1871 - 1913, in Thousands of Metric Tons**

Decade	Sugar Beets	Potatoes	Wheat	Rye	Barley	Oats
1875-84	5810	24,840	2,552	6,673	2,632	4,823
1885-94	9,510	30,460	3,045	7,237	2,666	5,587
1895-04	13,380	39,100	3,491	8,831	2,959	6,979
1905-14	16,090	45,790	3,956	10,665	3,244	8,382

Source:

Alan Milward and S.B. Saul, *Development of the Economies of Continental Europe, 1850 - 1914* (London, 1977, p. 54: Table 5.

Table 10.**German Agriculture:****Average Annual Application of Chemical Fertilizers****Kilograms per Hectare of Agricultural Land, 1878/80 - 1913/14**

Period	Nitrogen (N)	Superphosphate (P₂O)	Potash (K₂O)
1878-80	0.7	1.6	0.8
1898-00	2.2	10.3	3.1
1913-14	6.4	18.9	16.7

1 hectare = 2.47 acres

Source:

J.A. Perkins, 'The Agricultural Revolution in Germany, 1850 - 1914',
Journal of European Economic History, 10 (Spring 1981), p. 85.

Table 11.**Comparative Crops Yields in Northern Europe, 1790 - 1880**

Crop	France 1781-90	Germany c.1800	Germany, France, Belgium, c.1880	Germany, France, Belgium, c.1880
	quintals/hectare	quintals/hectare	quintals/hectare	metric tonnes: millions
Wheat	11.50	10.30	13.95	9.950
Rye	8.00	9.00	12.35	8.864
Barley	11.00	8.10	14.52	3.646
Oats	5.00	8.50	13.50	9.589

* 1 quintal = 100 kg.

1 hectare = 10,000 square metres = 2.471 acres

Source: Patrick Chorley, 'The Agricultural Revolution in Northern Europe, 1750 - 1880', *Economic History Review*, 2nd ser. 34 (Feb. 1981), 83.

**Table 12. The Populations of Selected European Countries
in millions, in decennial intervals, 1800-1910**

Year	Great Britain	Belgium	France	Germany	Russia
1800	10.7	3.1	27.3	n.a.	35.5
1810	12	n.a.	n.a.	n.a.	n.a.
1820	14.1	n.a.	30.5	25.0	48.6
1830	16.3	4.1	32.6	28.2	56.1
1840	18.5	4.1	34.2	31.4	62.4
1850	20.8	4.3	35.8	34.0	68.5
1860	23.2	4.5	37.4	36.2	74.1
1870	26.0	4.8	36.1 ^a	40.8 ^b	84.5
1880	29.7	5.3	37.7	45.2	97.7
1890	33.0	6.1	38.3	49.4	117.8
1900	37.0	6.6	39.0	56.4	132.9
1910	40.9	7.4	39.6	64.9	160.7

^a Excluding Alsace-Lorraine.

^b Including Alsace-Lorraine.

Sources: B.R. Mitchell and P. Deane, *Abstract of British Historical Statistics* (Cambridge, 1962), pp. 8-10; Carlo Cipolla, ed., *Fontana Economic History of Europe*, Vol. IV:2, pp. 747-48.

**Table
13:**

Labour Productivity in European Agriculture in the 19th century

measured in terms of the value of outputs, per agricultural worker

in terms of the value of the British pound sterling in 1910

Year	England/ Wales	France	Germany	Netherlands
1815	46	20	9	36
1840		22	16	37
1850	65		19	37
1860		36	26	37
1870	71	43	28	40
1880	79	37	35	38
1890	94	39	42	36
1900	108	34	49	38
1913	110	45	55	42
Percent Change 1815 to 1913	139.13%	125.00%	511.11%	16.67%

Source:

Astrid Kander and Paul Warde, 'Energy Availability from Livestock and Agricultural Productivity in Europe, 1815 - 1913: A New Comparison', *Economic History Review*, 2nd ser., 64:1 (February 2011), Table 1a, p. 2.

Table 14**Draught Livestock Numbers in European Agriculture in the 19th Century****In terms of the equivalent number of horses: in the thousands**

Year	England	France	Germany	Netherlands
1815	752	3,078	2,945	142
1840		3,218	3,232	
1850	812	3,317	3,272	161
1860		3,096	3,652	153
1870	802	2,857	3,741	168
1880	840	2,740	3,581	172
1890	892	2,571	3,972	163
1900	925	2,811	4,215	164
1913	808	2,316	4,626	180
Percent Change 1815 to 1913	7.45%	-24.76%	57.08%	26.76%

Source:

Astrid Kander and Paul Warde, 'Energy Availability from Livestock and Agricultural Productivity in Europe, 1815 - 1913: A New Comparison', *Economic History Review*, 2nd ser., 64:1 (February 2011), Table 2, p. 7.

Table 15:

Energy consumption, in terms of the caloric values of fodder crops consumed

by draught animals in 19th-century European Agriculture

measured in teracalories: 10 calories to the 12th power

Date	England	France	Germany	Netherlands
1815	6,460	26,343	24,491	1,213
1870	9,572	26,914	34,213	2,005
1880	10,384	26,241	33,625	2,126
1890	11,330	25,445	38,125	2,070
1900	12,223	28,333	41,109	2,153
1913	11,060	22,931	45,867	2,464
Percent Change 1815 to 1913	71.21%	-12.95%	87.28%	103.13%

Source:

Astrid Kander and Paul Warde, 'Energy Availability from Livestock and Agricultural Productivity in Europe, 1815 - 1913: A New Comparison', *Economic History Review*, 2nd ser., 64:1 (February 2011), Table 3, p. 8.

**Table
16:**

**Energy Consumed by Draught Animals per Agricultural Workers
in 19th century European Agriculture**

Measured in Gigacalories = 10 calories to the 9th power

Year	England	France	Germany	Netherlands
1815	4,061	4,093	2,570	3,158
1870	6,455	3,738	3,341	3,530
1913	9,735	2,679	4,633	3,500
Percent Change 1815 to 1913	139.72%	-34.55%	80.27%	10.83%

Source:

Astrid Kander and Paul Warde, 'Energy Availability from Livestock and Agricultural Productivity in Europe, 1815 - 1913: A New Comparison', *Economic History Review*, 2nd ser., 64:1 (February 2011), Table 4, p. 8.

**Table
17:**

**Livestock consumption of energy (fodder crops) in
19th-century European agriculture**

measured in terms Gigacalories per hectare of agricultural land

10 calories to the 9th power

Year	England	France	Germany	Netherlands
1815	0.54	0.88		0.68
1870	0.80	0.82	1.26	1.02
1880	0.87	0.81	1.22	1.05
1890	0.94	0.77	1.38	1.03
1900	1.02	0.87	1.48	1.03
1913	0.92	0.74	1.63	1.14
Percent Change 1815 to 1913	70.37%	-15.91%	15.00%	67.65%

Astrid Kander and Paul Warde, 'Energy Availability from Livestock and Agricultural Productivity in Europe, 1815 - 1913: A New Comparison', *Economic History Review*, 2nd ser., 64:1 (February 2011), Table 5, p. 10.

Table 18:**Draught Animal Energy Productivity in 19th-century European Agriculture****In terms of Agricultural Values, by Purchasing Power Parity Rates****based on the value of Pound Sterling in 1910
per Gigacalories**

Year	England/ Wales	France	Germany	Netherlands
1815	12	5	4	11
1870	11	12	8	11
1880	10	11	10	11
1890	11	11	11	11
1900	11	10	12	12
1913	11	17	12	12
Percent Change 1815 to 1913	-8.33%	240.00%	200.00%	9.09%

Astrid Kander and Paul Warde, 'Energy Availability from Livestock and Agricultural Productivity in Europe, 1815 - 1913: A New Comparison', *Economic History Review*, 2nd ser., 64:1 (February 2011), Table 6, p. 11.

Table 19:**Draught Animals Employed in 19th-Century German Agriculture****numbers: in the thousands****energy: measured in kcal: 10 calories to the 12 power**

Year	Horses	Oxen	Donkeys & Mules	Horse Equivalents	Total Energy
1815	1,656	1,924	7.0	2,945	24.5
1840	1,796	2,143	8.3	3,232	n.a
1850	1,868	2,095	9.0	3,272	n.a
1860	2,193	2,178	9.2	3,652	n.a
1870	2,319	2,122	10.0	3,741	34.2
1880	2,187	2,080	7.0	3,581	33.6
1890	2,522	2,164	4.5	3,972	38.1
1900	2,895	1,970	5.0	4,215	41.1
1913	3,145	2,210	8.0	4,626	45.8
Percent Change 1815 to 1913	89.92%	14.86%	14.29%	57.08%	86.94%

Astrid Kander and Paul Warde, 'Energy Availability from Livestock and Agricultural Productivity in Europe, 1815 - 1913: A New Comparison', *Economic History Review*, 2nd ser., 64:1 (February 2011), Appendix, p. 25.