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RESEARCH ARTICLE

Elevated to the ranks of a science: Manual labor and Albert Thaer's doctrine of rational agriculture

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Argument
This paper analyzes how the founding figure of German agricultural science grappled with the traditional hierarchies of knowledge undergirding the eighteenth-century agricultural improvement debates. By tracing the ways in which physical labor and farm management shaped Albert Thaer's doctrine of rational agriculture, I look at his position through the lens of a labor history of science. A close examination of the legitimizing strategies that Thaer deployed in order to counter persistent cultural taboos will highlight the role of conceptual work in pushing the bounds of legitimate scholarly practice. The paper concludes by arguing that changes in the relationship between scientific identity and manual labor form a transformative element in the history of science that can also be considered a criterion of discontinuity between its configurations before and after 1800.

Keywords: German agricultural science; Rational agriculture; Labor history of science; Albert Thaer; Agricultural improvement; Scientific identity; Manual labor in science

Albert Thaer (1752–1828) is a pivotal figure in the history of agricultural knowledge in German-speaking Europe. Historians have credited him with promoting economic liberalism in the form of profit-oriented "scientific" production, leaving behind early modern *oeconomy* as represented by paternalistic and feudal forms of subsistence economy (Simons 1929; Gray 1990). Thaer's lifetime coincides with the German age of revolutions or *Sattelzeit* between 1750 and 1850, when the Germanies were transitioning from a feudal agrarian society to a bourgeois and industrializing society. Since in eighteenth-century Germany *oeconomy* was largely based on agriculture, newspapers and journals frequently used the term interchangeably with agriculture. It is noteworthy that the early modern term *oeconomy* referred to the wise management of an individual household—typically a farm—under the leadership of a patriarch. We should therefore distinguish *oeconomy* from the nineteenth-century understanding of "the economy" as a self-regulating market with economic activities being indirectly coordinated by prices (see Roberts 2014; Firth 1998).

As a Prussian official, Thaer was involved in the most far-reaching agricultural reform of his time, aiming at dissolving the commons and favoring individual over collective forms of agricultural production. The commons reform in Prussia (*Gemeinheitsteilungsordnung*) formed part of a whole raft of political reforms launched by progressive bureaucrats after Prussia's defeat by Napoleon in 1806, aiming at nothing less than exchanging the old social order of the estates (*Ständeordnung*) for a new concept of equal citizenship. The Prussian reforms thus included,

among other things, the abolition of peasant serfdom and the freedom of choice of occupation for all estates. Promising not only to loosen the feudal and collective dependencies of peasant economy, but also to open up commercial agriculture to the bourgeoisie, the Prussian reforms had the potential to considerably dynamize agricultural production. Historians, however, consider the so-called peasant liberation (*Bauernbefreiung*) largely as a euphemism, as the reforms were soon modified in favor of the nobility and feudal dependencies actually persisted in most German territories (as did collective forms of production) even beyond the first democratic revolution in 1848 (Nipperdey 2013; Brakensiek 2000). As we shall see, Thaer embraced the innovative impulses of the political reforms, especially of economic liberalism, while at the same time remaining wedded, at least partially, to the inherited cultural norms of his day.

Within the history of science Thaer has usually been framed as a zero-point of modern science or as a transitional figure giving way to "real science", namely the chemical agronomy headed by Justus von Liebig (1803–1873). Previous studies have largely neglected the social and cultural context from which Thaer emerged, and which kept shaping his epistemological standpoint, particularly failing to contextualize Thaer against the background of the European improvement debates commonly referred to as the agricultural Enlightenment (Popplow 2010; Stapelbroek and Marjanen 2012; Jones 2016).[1] From the mid-eighteenth century, wealthy landlords, pastors, state officials and cameral scholars had been ostensibly concerned with increasing the yields and productivity of local economies while simultaneously striving to establish a new field of knowledge, which was envisioned as being "scientific" as opposed to conventional agriculture. Johann Christian Schubart's (1734–1787) passionate plea for clover cultivation on fallow land, or a new ploughing method propagated by Peter Kretzschmer (1693–1764) as a "tillage riddle" (*Ackerbaurätsel*), were among the proposals that were controversially discussed over the years, in periodicals, economic societies, price competitions etc. (Schubart 1784; Kretzschmer 1748). Numerous authors published hundreds of new books every year from the last third of the century onward; bibliographers lamented that it had become utterly impossible for one person to read all the new publications (for instance, Beckmann 1769, XIII, footnote). Magazines and monographs were not the only forms of representation of the reform movement; consider, for example, the alternative activities of the charitable and economic societies, such as essay competitions or seed gifts, princely administrations concerned with grain supplies, prize questions of the academies of science, or the private correspondence between educated landowners, to name but a few. However, the sheer volume of publications handed down is stunning. Today, we can find thousands of books and journals in library magazines throughout Europe and beyond, testifying to the "agromania" (Desplaces 1762) of the eighteenth century, especially in its second half. With a view to such conditions, contemporaries were already speaking of the movement as an agricultural Enlightenment, a *landwirthschaftliche Aufklärung* (Mayer 1788, preface).

Thaer was therefore not in a position to simply cast a new conception of "modern" agronomy into the world, but rather was himself cast by the historical dynamics he found himself in. He intensively grappled with the contemporary classifications of knowledge within which his thought remained partly anchored. Certain adjustments, however, and most prominently a new Kantian understanding of the meaning of "empirical," allowed him to promote the legitimization of a new set of experiential practices, concepts, and institutions, for which nineteenth-century agriculturalists and historians credited him with being both the founding figure of agricultural science and of industrializing agriculture. In the following, I will analyze Thaer as an agent of change, bringing the practical or useful sciences of the eighteenth century into what became called the experiential sciences (*Erfahrungswissenschaften*) in nineteenth century Germany. In the case of agriculture, these transformations cumulated within a relatively short time around 1800. I will

[1]Classical studies on the history of agricultural science highlight the mid-nineteenth-century emergence of soils chemistry after Justus von Liebig (1803–1873) as the "scientific revolution" in agriculture. These accounts often depict the literature and the agricultural practice of the Enlightenment period as utterly static. See, for instance, Finlay 1992.

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argue that during this period the relationship between scholarly identity and physical labor can count as a key indicator of a discontinuity between pre- and post-1800 configurations of agricultural science.

The lowliest of all mechanical arts

Despite being ubiquitous in early modern Europe, agriculture has to date not found the same consideration in the history of science and technology as, for instance, mining has, or other more prestigious mechanical arts, such as porcelain production, clockmaking, goldsmithery, or architecture (for instance, Klein 2020; Long 2011; Valleriani 2016; Roberts et. al 2007).[2] Historians have argued, in the tradition of Edgar Zilsel, that early modern artisanal techniques, such as testing in metal processing, showed parallels and inspired practices that later became "enshrined" as part of the scientific method (Smith 2014, 18). As cross-fertilization of artisanal and scholarly knowledge has most likely occurred from the beginning of the early modern period on, some historians advocate for discarding dichotomous differentiations, such as the separation of manual versus intellectual work, as outdated topoi (Roberts 2007, XVII).

At the level of historical semantics, however, the social hierarchies expressed by such dichotomies are a striking general feature we can hardly neglect. The conceptual opposition of mind versus hand, in particular, appears to permeate early modern sources like a grid pattern, regardless of genre, begging the question of whether it can be ignored as a cultural fact. This paper proceeds from the assumption that, in order to understand the rising status of phenomena connected to manual labor in academia, we must not exclude historical semantics from realm of historical examination. This includes, in particular, systematics of knowledge, along with their implied hierarchies and values, which have shaped—among other things—scholarly identity.

One benefit of considering historical semantics is that they allow us to examine the processes of re-evaluation by which contemporaries contributed to the gradual alteration of cultural norms that also impacted scientific practice. Cultural norms determined, for instance, what was considered suitable for men of high rank and qualified as "scientific" activity. Cultural norms possibly also provide explanations for why artisanal-cum-scholarly intersections largely remained informal through the early modern period, and why the work of low-status workers performed in natural knowledge production typically remained invisible. In terms of institutionalization, finally, it is conspicuous that prestigious technological institutions, such as mining academies, veterinary schools, or Thaer's agricultural academy, emerged only relatively late. In the German-speaking world, this occurred as late as towards the end of the eighteenth century (Klein 2020).

Precisely because of its low social status, agriculture presents a particularly interesting case in a labor history of science (on these prospects, see Rood 2016). Contemporaries in fact considered agricultural labor the epitome of mindlessness and routine, since it purportedly required merely the "exercise of the limbs" (*Übung der Glieder*), and no "presence of the mind" (*Geistesgegenwart*) or "use of the understanding" (*Gebrauch des Verstandes*) (*Oeconomische Encyklopädie*, 1791, s.v. "Kunst," accessed March 6, 2025, https://www.kruenitz1.uni-trier.de, quotes on page 95).

Engaging in the improvement of agriculture thus posed a greater threat to the social standing of high-ranking individuals than engaging in more prestigious mechanical arts such as clockmaking. As Lydia Barnett has recently argued, the labor of earth work, "in the dirt, out of doors," most clearly violated the early modern elite taboo against manual labor, and precisely for that reason European naturalists sometimes credited anonymous laboring-class individuals with finding the fossils that made up their collections. In this way, they explicitly clarified that they had not themselves dug in the dirt. Only later into the nineteenth century would emerging norms of

[2]These studies have also initiated a reevaluation of the relationship between scholarly and artisanal knowledge and the corresponding historiographies of science and technology.

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"rugged masculinity" allow men of high social standing to openly engage in the "earthiest forms" of scientific fieldwork (Barnett 2020, 250–251, 257; see also Kohler & Vetter 2016).

The precariousness that Barnett attributes to the earth sciences in terms of social status applies to agriculture as well. For instance, a noble German landowner reported in the 1770s that in the 1740s it had been considered *infra dignitatem* for young noblemen to engage in agricultural activities and in managing their farms themselves. In the meantime, he argued, it was high time for agriculture to go back to being "pursued and directed by noblemen predominantly as a science" like in ancient Rome (Schönfeld 1791, XLIV, XLVI). In his renowned book entitled *Experimental-Oeconomie*, Johann Gottlieb von Eckhart deemed it problematic that inventions in agriculture required "mostly sour and hard work," and for that reason could not be realized by "scholars" or "statesmen," but only by "sturdy country folk" and "persons of intermediate social rank" (*mittlere Standespersonen*) (Eckart 1754, 2). These statements are obviously situated in a social and cultural order, where not all activities were considered suitable for everyone, and literally everything could become a question of honor or its potential loss.

As middle-class agricultural improvers typically conceived of agriculture as the lowliest of all mechanical arts, defining "scientific *oeconomy*" (*wissenschaftliche Ökonomie*) thus represented not only a conceptual but also a sociocultural challenge. For, although the eighteenth century saw increasing numbers of bourgeois agrarian entrepreneurs and the active participation of gentleman farmers, a stigma remained attached to the actual back-breaking agricultural labor (Lehmbrock 2020). It is striking how contemporaneous typologies of knowledge echoed this stigma. For instance, agriculturalists commonly assigned a separate type of knowledge—the "manual-wise" (*handwerksmäßig*) or "empirical' way of farming—to the mass of mostly illiterate agrarian practitioners, which, in hindsight, appears as an almost compulsive gesture of boundary work.

The German agricultural literature of this period distinguished between three types of knowledge. For instance, a new *oeconomic* society introduced itself as comprising friends who regard rural *oeconomy* at times in a "purely theoretical," at times in a "theoretico-practical," and again at other times in a "merely empirical manner" (Anon. 1754, 669; see also Anon. 1751, 135). Incidentally, the sketched trichotomy of theoretical, practical, and empirical was in no way idiosyncratic, but rather followed ancient classifications of knowledge (see Pomata 2011). Note however, that the early modern understanding of "empirical" clearly differed both from that of classical antiquity and from modern versions of empiricism. According to Alberto Vanzo's analysis, "empirical" in the early modern period was primarily a polemical term used by scholars to dismiss unlearned practitioners in such diverse fields as administration, philosophy, or medicine (Vanzo 2014; see also Pomata 2011). Likewise, in the agricultural context, one author staunchly affirmed that studying *oeconomy* in a "scholarly" or "practical" manner was entirely distinct from and superior to any "empirical" and "manual-wise" approach (Anon. Einige Abhandlungen 1750, 620).[3] The "empirical," being a synonym of "manual-wise" (*handwerksmäßig*), was associated with the peasant way of knowing the land, and some authors would explicitly deem empiricism (*Empirie*) "incompatible" with science (*Wissenschaft*) (Weber, 1804, 9; cf. Inkster 2007).

While a hierarchization based on the notion of upper and lower cognitive capacities was not new, the authors of the agricultural Enlightenment were prone to carry it to the extreme. It is striking, for instance, how the stigma of agriculture was utilized in polemic disputes, when high ranking scholars disallowed the knowledge claims of writing landowners: "The common unlearned economist running a farm is no more a practitioner in the actual sense of the word than a peasant doctor and lawyer, since he merely applies his experience, which is what drives his actions: he practices, conducts economic dealings, and just like any peasant doctor and lawyer is

[3] „Wenigstens ist es gewiß, daß es ganz was anders sey, die Wirtschafft gelehrt und practisch, als nur empirisch, physicalisch, als handwercksmäßig, [zu] lernen, jenes aber besser als dieses sey."

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only an empiric, not a practitioner" (Weber 1804, 9).[4] As the author, cameral scholar Friedrich Benedict Weber (1774–1848), goes on to stress, only university-trained physicians and lawyers can be said to truly practice, as in his view, practice requires prior theoretical study.[5]

It is important to note here that, unlike the empiric, the practitioner (*Praktiker*) carried an almost entirely positive connotation for Weber and other authors of the German agricultural Enlightenment. Often used as a self-ascription, the practitioner was a *persona* that not only boasted personal agricultural experience but was also familiar with books and capable of written expression.[6] In this sense, the practitioner of the agricultural Enlightenment was a hybrid figure—a learned farmer—taking part both in the rural world of production and in scholarly discourse. By contrast, for members of the educated middle classes (*gebildete Stände*) who conceived of themselves as practitioners (i.e. as semi-learned), the world of a supposedly merely "empirical" farming constituted a tabooed area well until the end of the century.

Thaer himself also differentiated knowledge with his own trichotomy—into manual-wise (*handwerksmäßig*), art-wise (*kunstmäßig*), and scientific (*wissenschaftlich*)—and this classification kept structuring his epistemology even after the turn of the century. In keeping with the inherited tripartite conception, Thaer too held up as scientific those forms of knowledge that were grounded exclusively in the discernment of principles and rules, reasons and causes, and hence were associated with logical reasoning, the supposedly highest cognitive faculty of the mind. Thaer's art-wise agriculture was an equivalent of the positively connotated understanding of practice and the practitioner (*Praktiker*).

Obviously, the pejorative representations of peasant economy and epistemology, culminating in the term "empirical," provided no realistic description of rural society, but functioned as a metaphor that helped legitimize the project of agricultural improvement as an honorable field of activity suitable for men of higher rank (for more details, see Lehmbrock 2020). And while we barely have any authentic voices from peasant society, the few surviving ones express indignation over the fact that educated authors rarely acknowledged the palpable expertise of peasant farmers. Instead, as stated by a literate peasant, "in the great science of husbandry any miserable bungler fancies himself an authority" (Irlbeck 1834, 90; see also Lehmbrock 2022).

Inconvenient dichotomies

In the wake of the turn to practice in the history of science, the intellectual cardinal difference of mind versus hand has become somewhat awkward, and it is tempting to simply pass it over whenever it appears in sources. With the agricultural Enlightenment, however, related dichotomies were constitutive for its entire discourse, and one is hard-pressed to name an author who did not fall back on them. To be sure, while authors frequently differentiated between practitioners and theoreticians of agriculture (setting the lower-class empirics entirely apart), these categories were never clearly realized in socio-economic and epistemic terms. As a case in point, the editor of the pertinent magazine *Archiv der teutschen Landwirthschaft* and later university professor Friedrich Pohl (1768–1850) was raised on a small country estate, worked as the steward of an estate (*Gutsverwalter*), and in later years likely became a wealthy landowner

[4]„Der Bauer und gewöhnliche ungebildete Oekonom, der Wirthschaft treibt, praktiziert daher im eigentlichen Sinne des Worts ebenso wenig als [der] Bauerndoctor und Advocat, er wendet bloß seine Erfahrung an, er handelt darnach: er uͤbt, treibt die ökonomischen Geschäfte, und ist eben so gut, wie jener Bauerndoctor und Bauernadvokat nur ein Empiriker, kein Praktiker."

[5]With time, this academic notion of practice as a top-down process came to be increasingly contested in agrarian discussions, and Thaer chose Weber, of all people, as his intellectual antagonist, to which I will return later (for a contemporary critique, see also Matthesius 1792, 12, 15).

[6]A future research question could address how the identity of the agricultural practitioner relates to comparable early modern subject positions, such as the French *artiste* described in Bertucci 2017, 21.

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himself. He was a theoretician par excellence and, at the same time, clearly a practitioner of agriculture in terms of farm management (cf. Löbe 1888). The closest the label of theoretician came to a real social role was when it was attached to "public teachers" of economy, usually referring to university professors of the cameral sciences. Paired with the charge of practical ignorance, the term "theoretician" was most frequently used as a polemic attribution defending agricultural expertise against academic patronizing. For instance, a contemporaneous commentator noted sardonically that natural scholars (*Naturgelehrte*) did no more than "soften up a handful of dirt inside their drinking glass, stick a bean or onion into their flower pot, observe an aphid through the microscope, and at the utmost play around in their garden patch" (Anon. 1760, 504–5). Thus, a clear differentiation was made between scholarly practices of observation on the one hand and agricultural trials and fieldwork on the other.

Authors who identified as practitioners—wealthy landowners, stewards, or tenants of large estates, bourgeois or noble—also typically subscribed to a profit-oriented economic rationality, weighing costs and benefits in one variant or another, which was less a concern in naturalistic approaches (see Phillips 2018; Lehmbrock 2020, 140–170).[7] Thaer displayed a tendency to downplay the lines of continuity that connected his position to theirs, so that his knowledge claims might have appeared more novel than they actually were. In effect, upon closer scrutiny, it becomes apparent that Thaer's stance comprised the knowledge claims and practices of diverse groups of high-ranking farmers, state officials, and scholars, which makes him a compelling integrating figure in a history of science that is expanded into a history of knowledge.

Thaer's systematic treatise *Grundsätze der rationellen Landwirthschaft* (1809–1812), which was later translated to *The Principles of Agriculture* (1844), indeed prompted a temporary closure of the negotiation process as to what was to be understood by "scientific" agriculture. Already acknowledged as an authority during his lifetime, Thaer's seventy-second birthday was marked with a celebratory poem composed by none other than Goethe (Simons 1929, 232). From the perspective of institutional history, the opening of his agricultural academy during the French-Prussian war in 1806 in Möglin (Prussia) marked a momentous caesura, being as it was connected to a model farm and conceptualized in conscious distancing from the cameral sciences of the university, which delivered bookish lectures on agriculture.[8] In the course of the fifty years that followed, this institutional innovation became the norm in advanced agricultural academia, serving as a model for numerous similar institutions founded throughout Germany (see Reichrath 1991).

Nineteenth-century accounts began referring to the "school of the rationals," with the corresponding figure of the rational farmer becoming the *persona* of a profit-oriented and "scientifically" conducted agriculture.[9] Regarding this point, the common refrain from the nineteenth century onward consisted in the acknowledgement of Thaer having reconciled the dichotomy of agricultural theory and practice (Fraas 1852, 52, 81; Klemm 2002, 161–82). From the vantage point of more recent approaches to the history of science, such a succinct assessment calls

[7]In a sub-discussion related to costs and benefits, authors further differentiated the persona of the security-oriented prudent farmer from the risk-taker who, in a negative sense, was referred to as the quick-tempered (*brausköpfiger*) project maker. Regarding economic profit, it is also remarkable that under the media conditions of the later eighteenth century, writing about agriculture had become a business of its own, see Lehmbrock 2020, 140–170.

[8]Already some years prior, Thaer had founded his first agricultural college in Celle (Lower Saxony), see Thaer 1803. The late eighteenth and early nineteenth centuries saw a wave of academy foundations in the German territories promoting technological knowledge, such as the Freiberg Mining Academy (1765) in Saxony, the Tharandt Forestry Academy (1811) in Saxony, or the Munich veterinary school (*Thier-Arzney-Schule*, 1790) in Bavaria.

[9]The first generation of the "rational school" comprised Johann Gottlieb Koppe (1782-1863), Carl Philipp Sprengel (1787-1859), Johann Heinrich von Thünen (1883-1850), and Carl von Wulffen (1785-1853).

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for a more differentiated analysis. In the following section, I will focus on one important difference between Thaer and his predecessors in order to allow for a deeper understanding of how he constructed what later became celebrated as a historic synthesis.

Embracing manual labor and profit

It is noteworthy that, by maintaining the differentiation between manual labor, art/practice, and science, Thaer remained true to the established systematics of knowledge with its socially imbued hierarchy in all of his writings. However, unlike most of his academic peers, Thaer displayed a striking esteem for the "manual-wise" (*handwerksmäßig*) or "empirical" (*empirisch*) way of practicing agriculture. Much like his predecessors and contemporaries, he associated both terms with peasant economy. But, instead of assuming that lower forms became eclipsed by the respective higher, he conceived all three forms of knowledge as building upon each other. Thus, he recommended manual-wise learning even to his students, as he declared sensory perception and physical practice to be indispensable for the rational farmer as well.

Thaer postulated an intrinsic value in manual labor and proclaimed it a propaedeutic of scientific study. "Science requires a complete understanding of art (*Kunst*) and craft (*Handwerk*); for, without knowing and calculating the means for realization, it is wont to clinging to erroneous ideas" (Thaer 1815, 168). This assessment ties in with Thaer's experience as a manager of his own model farm, which was connected to the Möglin academy. Notably, model farms and institutions of higher agricultural education like Thaer's Möglin academy had already been called for in the earlier agricultural improvement debates (for an overview, see *Oeconomische Encyklopaĵdie*, 1807, s.v. "OĴkonomisches Institut," accessed March 6, 2025, https://www.kruenitz1.uni-trier.de).

The farm actually warranted the academy's status as an alternative to the cameral-sciences curriculum of agriculture as it had been taught at German universities since the 1730s. Granted, cameral scholars also kept seed cabinets and instrument collections in order to teach *Realien*, the givens of agriculture. Some even had a botanical garden, like Johann Beckmann (1739–1811) in Göttingen (see Beckmann 1769, X). Yet, the accompanying forms of experiential knowledge largely remained in-doors, and can hardly be compared to establishing and running an actual farm in the countryside, as documented in Thaer's diary of his farm, his *Geschichte meiner Wirthschaft zu Möglin* (Thaer 1815b).

In the farm's first year, for instance, Thaer's entire flock of sheep succumbed to pox. The cultivation of clover turned out to be an unmitigated failure, and only after thorough marl fertilization was Thaer able to achieve some success with it. As he admitted, he had previously not been "practically" acquainted with so-called *Schrindstellen* (i.e. barren sections in the field) (ibid., 11). In short, in contrast to the cameral scholar's standpoint, which Thaer continued to use as his intellectual rubbing ground, Thaer's perspective on agricultural science encompassed profound direct experiential knowledge. He promoted his teaching style at the Möglin academy as distinctly different from cameral lectures, including his own.[10]

Notably, Thaer did not exclude his own agricultural lectures from his general criticism. He argued that academic lectures, while suitable for cameral officials, pastors, and lawyers seeking to obtain a general overview, were insufficient for those who sought to master agriculture itself. As he emphasized, the latter demanded "sensory representation and inspection," which is exactly what he offered at his academy (Thaer 1812, 244). The academy was meant to appeal to the same target group, usually students of noble or bourgeois origins, but its objective was not to produce state officials, but truly scientific farmers.

[10]Thaer also held a cameral professorship at Berlin University in parallel to his Möglin institution, yielding him a considerable annual sum of imperial Thaler (*Reichstaler*).

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Building up his model farm may have taught Thaer the significance of knowledge derived from manual labor. He disallowed the notion that practical farmers could form by merely "observing" others at work—which is how the abovementioned cameral scholar Weber conceived of practical study. Departing from this notion, Thaer underscored that it is imperative for the learned economist to personally take over the "affairs" (see Weber 1804, 9, and Thaer's comment 1805, 238). The training of scientific or rational farmers—Thaer used both terms interchangeably—however, posed a complicated challenge, because students who had previously experienced university life were physically and morally spoiled, claimed Thaer, and it became almost impossible for them to acclimatize to the monotonous and grueling nature of country life (Thaer 1809, 19). While such statements may seem dramatically exaggerated, they address a fundamental challenge of the protagonists of agricultural improvement, namely how to link (scholarly) knowledge production and economic production, two spheres that were largely separated semantically, socially, as well as institutionally. Acknowledging the value of manual-wise knowledge meant admitting that a vital part of scientific agriculture consisted in personally managing agricultural production and leading an agricultural life.

Remarkable reflections on tacit knowledge or skill can be found in Thaer's various texts relating to the justification of his academy, which indeed represents a marked difference to previous epistemological debates among German agricultural improvers. For instance, he listed "physical training and strength," "patience," and a "perfect familiarity with the smallest of details" as indispensable preconditions for becoming a scientific farmer. All this could not be gained but through "one's own hands-on work." What is more, the scientific farmer had to study and know "the mentality of the laboring class of men" to be able to fully take their perspective. Necessary skills were also "rising early," "practicing moderation," "suppressing passionate outbursts," and paying attention even to "minor advantages to be gained" through industriousness (Thaer 1811, 95-6). Thaer's list, which reads like a bourgeois catalog of virtues, could not be taught, according to him, but needed to be practiced, for the bodily, implicit, or social knowledge considered essential for practicing agriculture could hardly be taught vicariously.

For this reason, Thaer recommended students spend a year working on a farm before enrolling in his academy. His academy then offered its own demonstrative teaching units, so that even concrete hand movements could be trained in a class setting, if needed. Thaer also underlined that operational practice not only imparted physical dexterity but also complex cognitive skills, such as the mental cultivation of an "inner measure" for space, time, and energy, which was indispensable for effectively coordinating the interlocking work processes and cycles in a complex manorial economy (ibid.). He advocated for the preservation and integration of these forms of knowledge into teaching practice, dismissing as insufficient and even detrimental any approach to scientific teaching that excluded instructions on how to calculate the time and energy required for each operation. In doing so, Thaer equipped agricultural science with an economic theory in the sense of farm management that later culminated in a book called *Guide to Agricultural Business* (*Leitfaden zur Gewerbslehre*), claiming that a rational farmer would first calculate the costs and expenditures associated with any change to be undertaken, and only take action when a profit seemed relatively certain (Thaer 1815).

Thaer contrasted this approach to that of many authors who were inclined to turn fields into botanical gardens and recommend vigorous fertilization, meticulous work, and generous expenditures, with no further consideration of how to actually procure the necessary means (Thaer 1805, 240-41; Thaer 1815, 177). Put differently, he criticized the cameralists' and naturalists' neglect of business and commercial aspects, of economics in a modern sense. As already mentioned, considerations of cost and benefit were not new; numerous authors had actually made similar claims in previous decades, whether it be gentleman farmers, bourgeois tenants, or literate peasants. Thaer, however, successfully incorporated the new perspective of (classical) economics into his concept of agricultural science.

Thaer argued that commercial aspects, as represented by the chief goal of maximum profit, had to take precedence even over science. Agricultural scientists and historians of the late nineteenth century retrospectively acclaimed his 1815 guide to agricultural business as the seminal work of agricultural economics, by now a separate discipline of the agricultural sciences.[11] Explicitly referencing the political economy of Adam Smith (1723–1790), Thaer took the perspective of the individual self-interested farmer, in a way anticipating the economic subjectivity that the Prussian reforms (1807–1815) were to unleash by introducing, among other things, freedom of trade, free choice of profession, and the end of personal serfdom in Prussia. Note also the cultural and semantic shift: during the eighteenth century, individual profit-making had still been perceived as an a-social behavior in conflict with state economy and the common good. Profit, accordingly, did not feature prominently in early modern descriptions of *oeconomy*, featuring notions of harmony instead, as well as religion, medicine, and the social relations between father, mother, maids, servants and farmhands in an agricultural household (see Gray 1990).

It is noteworthy that Thaer's focus on the rational farmer somewhat eclipsed the collective economic agent of the family. Thaer championed individual commercial activities over benefits to the national treasury—even if that sometimes meant accepting inferior quality and smaller quantity in favor of higher profit (Thaer 1805, 227). His statements also suggest that farmers were practicing according to the profit principle long before it was de-tabooed and validated as a general principle of economic thought. Rural history supports this view, suggesting that profit-oriented activities have always occurred—in all social strata—when markets were nearby and offered economic chances. Decisive for a market-oriented mindset were, however, favorable conditions in each individual case, determining, for instance, if profits were skimmed off by a landlord or not. Theoretically a socially inclusive concept, the rational farmer actually presupposed economic freedom (i.e. independence from feudal as well as cooperative production structures in the villages), which largely defied individual choice activities. For many practitioners the rational farmer was thus not (yet) an attainable *persona*, even though the Prussian state had started promoting liberal economic institutions for all estates. It seems worthwhile to further explore the developments taking place within academia in parallel to these transformative trends in the political and societal fields.

The practice and meaning of "science"

As mentioned above, Thaer's critical stance towards cameralist approaches to agricultural production also extended to his own lectures at Berlin University, which he thought were only appropriate for providing a general overview for future civil servants, cameralists, legal scholars, or theologists. However, he conceded lectures could also help practical farmers who wanted "to rise to a scientific view" (ibid., 237–38; Thaer 1812, 244–45). Thaer's wording reveals a common attitude which frequently found expression in the agricultural improvement debates. As some historians of science and technology have set forth, the key reform strategy adopted by agricultural improvers was to collect and disseminate practical knowledge, typically treating agriculture as one more aspect of natural history (Popplow 2010; Lowood 1991). In the words of Johann Beckmann (1739–1811), professor of *oeconomy* in Göttingen, experiences, discoveries and suggestions lay "dispersed and concealed in a tremendous amount of the most diverse periodical writings, collections, and magazines" (Beckmann 1769, XI). The classic scholarly task, then, was to collect

[11]Before Thaer, *Gewerbslehre* ("doctrine of business") played a conspicuously subordinate role—and sometimes even no role at all— as compared to the natural sciences, in the debates about scientific agriculture. In 1826, Friedrich Gottlob Schulze (1795–1860) still had reason to identify and criticize the general neglect of economics. In clear divergence from the mainstream, his concept of *Landbauwissenschaft* assigned a much more important role to economics than to natural sciences; cf. Schulze 1826, 19.

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and order these "truths" according to more abstract concepts. In 1750, an author had speculated that if only the empirical principles of farming would be "presented in a well-ordered manner," they could "already be admitted amongst the sciences" (Anon. 1750b, 75). Beckmann's guide to technology, his *Anleitung zur Technologie*, was just such a systematic description. It presented different trades and arts in a "natural order," ranging from the simplest to the most complex, from butcher to doll maker to stove fitter and belleter (Beckmann 1777). Tellingly, he had written the book as an overview for state officials entrusted with *oeconomic* tasks, not aiming at training craftspeople. Hence, there is nothing hybrid in Beckmann's *Technologie*, as the different types of knowledge and the corresponding practices remain well separated.

Against this backdrop, Thaer's doctrine of "rational agriculture" shows a marked shift in that it argues for acknowledging scientific aspects in the agricultural production itself, which was also implied in the corresponding *persona*, the rational (or scientific) farmer. While many elite agriculturalists still took for granted that a scientific understanding could only be obtained through university study, the striking feature of Thaer's argument was the equation of successful agrarian production to agricultural science. Thaer's scientific farmer was, by definition, also the most productive farmer. Unlike former conceptions, his notion of agricultural science thus included the activity of farming itself. This shift entailed one important consequence, which is particularly relevant to this paper. Thaer's doctrine of scientific agriculture no longer had to rely on external information that scholars would then have to recast into a scientific form. His version of agricultural science exerted control over the entire agricultural production process, and therefore over all related bodies of knowledge and practices.[12]

This shift implied that Thaer's approach no longer relied on some kind of raw data provided by low-status informants, as in previous ways of encyclopedic and classificatory system building. Instead, the science of rational agriculture began producing all relevant elements of knowledge by itself, resulting in an autonomy that sociologist Rudolf Stichweh has defined as essential for constellations of science post 1800 (Stichweh 1994, 50). And yet, when presenting his doctrine of rational agriculture, Thaer kept relying on a literary genre that was certain to be accepted as "scientific" by the standards of his contemporaries and even by conservative academic peers, namely the genre of the system.

At this point, it seems necessary to inspect the exceptional status occupied by the system and systematic thought in the German speaking debates on scientific agriculture, and the contemporaneous understanding of science itself. For most agricultural improvers, the term "scientific" either explicitly or implicitly referred to a deductively structured representation of knowledge laid out with didactic intent in systematic lectures or systematic books (see Lehmbrock 2020, 194–202). Most authors also took for granted that systems represented the genuine form of science. Mastering the systematic genre was therefore regarded as the key skill distinguishing a person as a scholar. Agriculturalists typically assumed that once a scholar had established the correct principles (*Grundsätze*), a complete system of agriculture would arise, which would then also provide the basis for a perfect practice. The treatment of agriculture as a science thus required collecting and organizing existing agricultural knowledge—no matter its origin—and postulating general principles, under which these agricultural "truths" could be ordered and logically derived. Indeed, the pronounced reverence for the system can be found among all competing fractions of the German agricultural Enlightenment. Most authors even aspired to a true system (*wahres System*) of agriculture as the ultimate goal of their own efforts.

The common rejections or polemics against the spirit of system or *esprit de système,* as abundantly documented for French and English discourses, are indeed conspicuously absent from the German debates of that time. On the contrary, authors prized systematic thinking as

[12]Arguably, the case of "rational agriculture" is one exemplar of a more general strategy of incorporating low-status knowledge into learned bodies of knowledge and practice. Future research might reveal, for instance, how European cases relate to contexts of colonial science and its dealing with forms of subaltern knowledge.

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something unreservedly positive, which was also not in any conflict with experiential knowledge or practicality (for details, still see Stein 1968). The systematic vision of science likewise integrated both truth and utility, and German agriculturalists often claimed both at the same time. Instead of oscillating between two poles, as Dear (2005) has proposed as a model for the history of science, it is striking that truth as a literary commonplace was never suspended in favor of utility. In this respect, we can regard the German concept of the system as a mediating instance between various ideals and practices of scholarly knowledge. Not only did the system figure as a container for experiential knowledge; it was also definitely considered useful because an accurate system would eventually help elevate agricultural practice to perfection.

University scholars, in particular, were the masters of the systematic genre, producing so-called systems of agriculture, such as Beckmann's *Grundsätze der teutschen Landwirtschaft*, which was among the most comprehensive books of the agricultural Enlightenment. Authors collected the particulars for these systems by way of conversation with practitioners during agricultural excursions (*ökonomische Reisen*) and through extensive literary studies. Remarkably, as writing practitioners such as wealthy landowners and state officials began entering public debates, publishing their own articles and sometimes monographs in the course of the eighteenth century, they too felt obliged to present their findings in a systematic format. As shown in the *Leipziger Sammlungen*, one of most comprehensive economic journals, German authors consistently chose the genre of systematic treatise to write about agricultural topics. Tellingly, the genre of observation, which historians of science have carefully studied in recent years, is completely absent from the *Leipziger Sammlungen*, although at least some authors certainly could have reported from their own experience (on observation, see Pomata 2011b).[13]

It is plausible to attribute this preference for the systematic treatise to the extraordinary reverence that the concept of the system enjoyed as the perceived hallmark of scientificity in German scholarly discourse and the wider public. In the long run, the type of scientific agriculture that relied on compiling bodies of knowledge and structuring these in systematic books and lectures waned not suddenly but only gradually to eventually completely disappear towards the mid-nineteenth century—very much like the cameral sciences. But even as after 1800, when German publications increasingly and then almost exclusively defined agriculture as an experiential science (for instance, Sturm 1819, 4; Burger 1819, V), as late as in the 1820s, a reviewer criticized the new textbook by Johann Burger (1819), who had defined agriculture as an experiential science. Deeming any construct comprising experience and science an "absurdity," the reviewer stated:

> After all, experience can never be anything more than experience, and as such can by no means be made into a science, since otherwise any man who is experienced in his field, and consequently also the peasant experienced in agriculture, would have to be considered a man of science. As a consequence of this error, science is unappreciated and degraded by this hermaphrodite term. (Anon. 1821, 224)

Against this background, is becomes clear how Thaer's re-conceptualizations tied into the broader trend and justification of what would become called the "experience-sciences" (*Erfahrungswissenschaften*) in the German-speaking world after the turn of the century.[14] In his *Grundsätze der rationellen Landwirthschaft*, Thaer postulates that his science of agriculture

[13]English agricultural improvers demonstrably chose less extensive genres, particularly the genre of observation, and represented their reflections as grounded in what could be perceived individually through one's own senses. German authors instead tended to treat topics comprehensively instead of reporting their own observation. This resulted in significantly longer articles, averaging twenty pages, and sometimes even more than a hundred. See the comparative case study in Lehmbrock 2020, pp. 202–211.

[14]Separating the new natural sciences from natural philosophy met with strong cultural resistance in the German territories, as the quote on experience and science above demonstrates (on this topic, see Bayertz et al. 1982 and Breidbach & Ziche 2001).

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rests on experience and thus may be subjected only to the claims that can be raised towards an "experience-science". He declares that its substance can only be captured "empirically that is, through sensory perception" (Thaer 1809, 7). Interestingly, Thaer's definition not only draws on the controversial category of experience-science, but also incorporates the term *empirical* in a non-pejorative way. In fact, he explains in a sub-clause that "empirical" should be simply understood as knowledge captured through sensory perception.

To grasp the importance of Thaer's linguistic choices, one has to briefly consider the history of the concept of empiricism. As mentioned above, during the early modern period "empiric" and "empirical" were polemical terms used by scholars to dismiss competing knowledge claims of unlearned practitioners. The Encyclopaedia Britannica referred exclusively to the empiric medicine under the lemma "Empiric" and likewise defined the term as a polemic ascription: "Empiric, an appellation given to those physicians who conduct themselves wholly by their own experience, without studying physic in a regular way. Some even use the term, in a still worse sense, for a quack who prescribes at random, without being at all acquainted with the principles of the art" (*Encyclopaedia Britannica* 1842, 693).[15]

Analyzing the word use in Latin, German and English texts, including those of the renowned Francis Bacon, Joseph Priestley and Christian Wolff, Vanzo has observed that none of the examined authors used the terms *empirically*, *empiric* or *empiricism* in a non-polemical manner. Arguably, only Immanuel Kant's redefined notion of "empirical," introduced in his *Critique of Pure Reason* from 1781, was no longer pejorative, and it is within the debates on Kant's *Critique* from the 1790s onward that Vanzo detects a change from the pejorative designation of the empiric to a positive self-ascription as "empiricist" (Vanzo 2014; see also Ratcliff 2018). As a *terminus technicus* in Kant's theoretical philosophy, "empirical" simply referred to perceptions which relate to an object via sensation, a signification that still remains valid today (Kant 1781, 93–4).[16] Incidentally, Kant provides explanations of the meaning of "empirical" with almost every use of the word in his *Critique*—an indication of how uncommon his use of the term still was at the time. For instance, Kant describes space as a pure form of perception, which "does not include any sensation," adding in brackets: "(nothing empirical)". (ibid., 104; see also 117).

In the agricultural debates before and during Thaer's time (i.e. during and in the thirty years following Kant's *Critique*), however, authors kept regarding the "empirical" way of farming as an unlearned and manual skill, often depicting it as the peasants' way of knowing the land. "Empirical," for most contemporaries, could therefore hardly count as scientific, and a category like "empirical sciences" would have struck Thaer's contemporaries as entirely nonsensical. However, during the late eighteenth century, a shift in the meaning of empiricism occurred, which can best be illustrated by Thaer's own language use. In an earlier statement, Thaer polemicized against the common cameral practices of scientific agriculture (*wissenschaftliche Ökonomie*) in a review, wherein he informed his cameralist colleague Weber that within five to six months those of his students who turned out to be the best were those who had come to him as "mere empirics" (*Empiriker*), as "manual-wise oeconomists" (*handwerksmäßige Oekonomen*), unfamiliar with oeconomic books (Thaer 1805, 238). Note that, at that point, *Empiriker* was still commensurate with "manual-wise" and a lack of book knowledge. This statement apparently still drew from the early modern connotation of an unlearned practitioner, which is additionally highlighted by Thaer's assertion that these students had been completely ignorant of books. However, only a few years later in 1809, Thaer's dictum in his *Principles of Agriculture* that the basic material

[15]The article remained unchanged in eight editions between 1771 and 1891.

[16]Incidentally, Locke, Berkeley and Hume, would have never called themselves 'empirical philosophers.' They could be denoted as 'British empiricists' only after Kant's critical philosophy and its reception, from which a clear distinction between rationalism and empiricism had emerged. Thaer's case thus gives rise to the question as to what role Kant's theoretical philosophy played in the formation of modern natural sciences in the German-speaking world.

(*Grundstoff*) of agricultural science had to be "empirical" apparently referred to the newer, Kantian connotation.

From a socio-historical point of view, Thaer's blending of the two variants of "empirical" can be considered extraordinarily important. For, as long as "empirical" was primarily a pejorative term associated with manual skill and low-rank practitioners, Thaer's conceptual inclusion of the term also meant, at least to a certain extent, acknowledging the way peasants knew the land. Thaer could already rely on Kant's innovative language use of "empirical" as knowledge drawn from sensory perception regardless of social status. However, at that point, the Kantian notion was not yet general knowledge within the agricultural public. Rather, the historical records suggest that, for most authors, negative connotations of the peasant economy and epistemology continued to crystallize in the term "empirical" until the turn of the century and even far beyond.[17]

Hierarchies of knowledge and manual labor in the history of science

Even as hierarchies of knowledge can prove to be extremely persistent structures, they too rise and fade in the course of history. Both the challenge and the achievement of German agricultural improvers consisted in combining low-status knowledge with the dignity of a science in its then meaning and in a German intellectual context. Thaer, as an advocate both of liberal economic reforms and of experiential knowledge, actively reinterpreted and modified the hierarchies of knowledge that undergirded the agricultural improvement debates, and in doing so, he created the cultural space for new understandings, practices, and institutions of agricultural science. As has been demonstrated in this paper, the historical semantics of manual labor provide a strong marker of discontinuity, which separates constellations of agricultural scholarship and science in pre and post 1800 Germany.

Effecting change in this period was tantamount to upvalueing bodily or so-called "mechanical" knowledge and constructing an understanding of science that incorporated values and skills connected to agricultural labor and management. Making an argument for the coherence of scholarship, profit, and manual labor, however, involved breaking with powerful cultural norms linked to early modern social order and epistemology. Social stigmas surrounding manual labor had long hampered the recognition of bodily knowledge involved in agricultural production within elitist discourse. And yet, during the Enlightenment period, middle-class authors increasingly claimed that they were elevating the mechanical art of agriculture to the "ranks of a science." Agricultural scholarship was, in turn, becoming ever more hands-on, which ultimately meant more rural. Wealthy landowners, state officials, and other practitioners from the educated classes (*gebildete Stände*) broke the discursive ground from which Thaer's doctrine of "rational agriculture" would emerge at the turn of the century (see also Phillips on educated classes 2012, 57–8).

Social and conceptual change went hand in hand. To the extent that new social groups from a rising bourgeois middle class asserted their claims to knowledge, new forms of knowledge came to be acknowledged as scientific. That people of so-called higher ranks condescended to agricultural practice in order to elevate it to the rank of a science, as a commonplace would have it, also meant that learned knowledge could not remain as it was. Men like Thaer, adopting new *personas* such as the rational farmer, no longer subscribed to an inherited contemplative ideal of science that set scholars unambiguously apart from matters of material production.

My analysis of the relevant historical semantics revealed how Thaer engaged in pushing social and cultural boundaries, thereby altering the bounds of scientific practice. He upgraded knowledge derived from manual labor in a manner that was strikingly affirmative for his time and

[17]Notably, in the English translation of Thaer's *Grundsätze der rationellen Landwirthschaft* the term *empirisch* was still not translated literally but circumscribed with "experience" as late as in 1844, see Thaer 1844. 3.

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context. This is clearly evidenced by his instructions for training high-rank farmers at his academy and farm, but also by his use of the terms *Empiriker* and *empirisch*, the meanings of which oscillated between a pejorative and polemical early modern connotation and a socially egalitarian connotation as introduced by Kant's epistemology. Due to the ambiguity of the term, Thaer's doctrine of rational agriculture could be understood by contemporaries as integrating into scholarship what was previously considered the peasants' way of knowing the land.

To be sure, this did not mean that simple village dwellers had the opportunity to actively participate in the construction of a new scientific field. Rational farmers à la Thaer also rarely ever worked a plough themselves. Thaer's perspective was primarily that of private property landowners in a liberal market economy, which the economic Prussian reforms (1807–1815), and Thaer himself in his role as an administrator, had begun promoting at the time, including the abolishment of personal serfdom, the freedom of trade and choice of profession in Prussia. However, despite the political and the agricultural reforms which aimed at unleashing new economic activity, feudal and cooperative village structures persisted in Prussia, as in most German territories, well until the first democratic revolution in 1848. While Thaer's rational farmer as a *persona* was theoretically not limited to a noble or bourgeois background, it was thus hardly attainable for the majority of the rural population in the early nineteenth century.

As a *persona* attuned to the educated classes, the rational farmer was, however, expected to be fully aware and in control of all knowledge types across the social strata—including the knowledge of labor. To the extent that Thaer's approach redefined knowledge derived from manual labor as an integral building block of science, his doctrine can therefore also be seen as appropriating peasant ways of knowing. This fact loosely aligns the history of agricultural science to colonial processes of knowledge translation and appropriation. Not least for this reason, the relationship between scholarly identity and manual labor still deserves far more attention. It may serve as a criterion of discontinuity between different constellations of science before and after 1800, and it also allows us to better understand how scientists took part in broader processes of social change.

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