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The Magic of One.

Reflections on the Pathologies of Monoculture

Introduction: The Mind of Monoculture

In the twenty-first century world, few words in agriculture have such an inherently negative ring as the term "monoculture". It does not need long explanations to see its inherent risks: monocultures exhaust soils, breed plant diseases, produce horrendous weed and pest problems, in addition to the labor problems and economic risks that go along with a sole reliance on a single crop. Since the nineteenth-century dispute over coniferous monocultures in Central European forestry, a critical line of thought runs through the modern agricultural and biological sciences, and there is no lack of powerful illustrations for the hazards of monoculture: from the Sigatoka fungus that wiped out the small banana producers in Honduras to the repercussions of the Green Revolution in India.[1] Biological diversity has become a buzzword in agricultural circles long before the environmental movement embraced it in the late twentieth century.[2]

Yet monocultures rule the world, and they show little sign of relenting in the twenty-first century. Most of our food comes from monocultures, and their hegemony looks even more drastic on second sight: as Michael Pollan noted, "The great edifice of variety and choice that is an American supermarket turns out to rest on a remarkably narrow biological foundation comprised of a tiny group of plants that is dominated by a single species: [...] corn."[3] Probably starting with the sugar cane plantations in the Caribbean, agricultural societies and ecological systems all over the world have been challenged by monocultures of a peculiar kind: large, market-oriented production systems with an industrial-style division of labor and a huge resource input. Researchers have looked into many of these production systems individually, but it is probably time to look at the challenge of monoculture more fundamentally and more globally. Why do we continue to live in a world of monoculture while the case for biodiversity has, if anything, grown in strength over time?

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1 John Soluri, *Banana Cultures. Agriculture, Consumption, and Environmental Change in Honduras and the United States* (Austin, 2005), 112; Vandana Shiva, *The Violence of the Green Revolution. Ecological Degradation and Political Conflict in Punjab* (Dehra Dun, 1989); John H. Perkins, *Geopolitics and the Green Revolution. Wheat, Genes, and the Cold War* (New York, 1997).

2 Timothy J. Farnham, *Saving Nature's Legacy. Origins of the Idea of Biological Diversity* (New Haven and London, 2007).

3 Michael Pollan, *The Omnivore's Dilema. A Natural History of Four Meals* (New York, 2006), 18. Emphasis original.

Small in length but wide in ambition, this paper, and the ongoing research it presents, depart from the assumption that monoculture is more than a biological phenomenon. At its core, monoculture is an uneasy mixture of several divergent rationales:

- an economic rationale: concentration on one crop allows for the use of comparative advantages and "economies of scale" – but also makes for a risky dependency.
- a technological rationale: special machines require a decent load factor in order to pay off.
- a scientific rationale: research may advance faster if scientists concentrate all energies on one crop – but that implies that the knowledge base may become precariously narrow over time.
- an ecological rationale which stresses the multiple environmental hazards of monoculture.

In order to understand monocultures, it is crucial to see that these rationales, and the processes that they mirror, are at the same time independent of each other and closely interconnected. The different rationales of monoculture need some kind of arrangement and coordination for the agricultural endeavor to become permanent, and this arrangement is often an improvised one, with many ambiguous compromises and a strong preference for externalizing costs. The co-existence and interaction of divergent rationales makes monocultures inherently unstable and surprisingly durable at the same time. After all, if anything can be said about the world of monoculture, it is a world in constant flux.

These divergent rationales make it rewarding to study monoculture as an intellectual endeavor, and to focus on what one might call the mind of monoculture. With few exceptions, monocultures are highly unnatural entities, and that means that they require some kind of human blueprint to develop: a conscious endeavor to build a production system around a single plant. To be sure, this blueprint is usually an improvised one, growing from everyday practices and experiences into an actual mode of production. It remains to be seen how many systems of monoculture emerged as a result of systematic central planning, but it does seem that those who did, like Henry Ford's "Fordlandia" or the Soviet-commanded cotton plantations in Central Asia, made a particularly poor showing.[4] At any rate, the role of science in the world of monoculture is an ambiguous one, and the project shall see their role and influence as a highly contested one. The one certain thing about scientists is that they could never run the show all by themselves. After all, there was never a scientific theory of monoculture but merely a *practice* of monoculture which begat a wide range of tasks and challenges for an equally wide range of scientists and experts all over the world.

The following remarks will concentrate on Germany until the conclusion will discuss some more general implications of the story at hand. This geographic choice is arguably less than creative for a German historian, and yet it is rewarding to approach the topic from a country that his-

[4] Greg Grandin, *Fordlandia. The Rise and Fall of Henry Ford's Forgotten Jungle City* (New York, 2009); Julia Obertreis, "Der 'Angriff auf die Wüste' in Zentralasien. Zur Umweltgeschichte der Sowjetunion," *Osteuropa* 58:4-5 (2008): 37-56.

torically comprises a great deal of geographic and agricultural diversity. The transformation of agriculture around 1800 stressed the merits of sophisticated crop rotations in order to get rid of the old three-field system with its periodic fallows; in fact, crop rotations were the defining issue for the first generation of agricultural scientists in the early nineteenth century. Nonetheless, the trend towards industrial-style agriculture in Germany ultimately brought a growing emphasis on monocultures and narrow crop rotations. In order to add some spice to the seminar discussion, I might add that this trend has surprisingly little to do with the high modernist mindset that James Scott stressed in his *Seeing Like A State*.[5] The transformation of German agriculture gathered steam in the post-war years after many controls over farming methods, imposed in the wake of autarky policies since 1914 and intensified by the Nazis, were relaxed or lifted. In fact, the liberty of the farmers became a matter of state ideology in the 1950s and 1960s, as the family farms of Western Europe were proudly juxtaposed to collectivization behind the Iron Curtain. In any case, the world of monoculture grew "from the ground up" in Germany, with strong input from the farmers and a rather precarious position for experts. I will leave it to the discussion whether this is an exception, a fundamental challenge, or an issue altogether irrelevant for the theory of high modernism.

In the Land of Liebig

In a study that stresses the limits of science-based agriculture, German agriculture is a particularly interesting case. After all, it is widely acknowledged that Germany was one of the first nations to support academic institutions for the study of agricultural issues.[6] Prussia supported an Academy for Agriculture in Möglin since 1804, which became a hub for the emerging expert network under the guidance of Albrecht Daniel Thaer. Other German states followed suit, and more than a dozen academies were founded until 1858. The next step came in 1863 when the University of Halle became the first German university to create an institute for agriculture. By way of comparison, the U.S. Congress had passed the Morrill Act creating the Land Grant system the previous year.[7]

In spite of these early institutionalizations, it is not difficult to identify limits in the reach of science-based agriculture. One obvious limitation was the number of academically trained farmers. Even Thaer's widely acclaimed Möglin Academy had only a total of 511 students between

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5 James C. Scott, *Seeing Like a State. How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, 1998).

6 Cf. Mark R. Finlay, "The German Agricultural Experiment Stations and the Beginnings of American Agricultural Research," *Agricultural History* 62:2 (Spring 1988): 41-50, and Nathalie Jas, *Au carrefour de la chimie et de l'agriculture. Les sciences agronomiques en France et en Allemagne, 1840-1914* (Paris, 2000).

7 On these overarching issues, see Frank Uekötter, *Die Wahrheit ist auf dem Feld. Eine Wissensgeschichte der deutschen Landwirtschaft* (Göttingen, 2010).

1806 and 1840.[8] However, the more pertinent issue were the limits of its cognitive powers. In the eighteenth century, the enlightenment author Johann Beckmann had argued that one can teach agriculture "in two ways, and that is either practically or scientifically".[9] Few agricultural experts went that far in the nineteenth century; in fact, some scientists frankly admitted in the twentieth century that their claim to expertise rested on a shaky foundation: "Generally speaking, the agricultural sciences differ from other scientific disciplines in that they are so far lacking a deep and thorough reflection of their methodological foundations."[10] Of course, experts claimed to have special knowledge in some regards, but they were in no position to provide a blueprint for farming. As they saw it, they were offering advice on some specific issues in order to increase productivity. In essence, they were friendly assistants, always mindful that no farmer was obliged to listen, or even to talk to them.

In order to understand the self-image of nineteenth-century experts, it is revealing to see how the scientific mainstream discussed those experts who were arguing for a more assertive role. Justus von Liebig, who sought to revolutionize farming with his agrochemistry, provides a particularly interesting case in point. While Liebig's credentials in chemical circles were stellar, agriculturalists were reluctant even while they saw the merits of mineral fertilization that Liebig had touted so eloquently: from their point of view, Liebig was a dubious hothead at best and a "dilettante" at worst, the latter being Richard Krzymowski's charge in a treatise on the agricultural curriculum.[11] In 1872, Gustav Drechsler, director of Göttingen University's School of Agriculture, stressed the limits of agrochemical expertise: the chemist was in no position "to develop a 'theory of crop farming' or a 'theory of livestock production'", and any idea to the contrary was a dangerous "aberration".[12] Others noted that Liebig was just as "one-sided" in his propagation of mineral fertilizers as Thaer and others had been in their penchant for humus and organic matter.[13]

If there was a broad consensus within the agricultural science network around 1900, it was that agriculture was a complicated business, that many things were interacting in a complex way on farms, and that experts were thus well advised to proceed cautiously. Agrochemists were even reluctant to offer precise instructions when it came to fertilizer use: "you will not bother me with such a silly request", Paul Wagner, head of the Darmstadt Agricultural Experiment Station, stated in 1906, instead calling upon the farmers to identify the fertilizer needs with the help of his

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8 Walter Achilles, "Agrarkapitalismus und Agrarindividualismus – Leerformeln oder Abbild der Wirklichkeit?" Vierteljahresschrift für Sozial- und Wirtschaftsgeschichte 81 (1994): 497.

9 Johann Beckmann, *Grundsätze der teutschen Landwirthschaft* (5th edition, Göttingen 1802), 7.

10 Otto Nolte, "Betrachtungen über den Felddüngungsversuch," *Fortschritte der Landwirtschaft* 2 (1927): 20. In order to understand this statement, one should take note that Nolte was a trained scientist who had a habilitation and worked on fertilizer issues with the Deutsche Landwirtschafts-Gesellschaft, a key organization with the German agricultural science network.

11 Richard Krzymowski, *Philosophie der Landwirtschaftslehre* (Stuttgart, 1919), 27.

12 Gustav Drechsler, *Das landwirthschaftliche Studium an der Universität Göttingen* (Göttingen, 1872), 29.

13 Arnold v. Nostitz, Josef Weigert, *Die künstlichen Düngemittel. Die Handelsdünger unter Berücksichtigung der Wirtschaftsdünger* (Stuttgart, 1928), 14.

manuals.[14] The agricultural knowledge society of the late nineteenth century was a polycentric one, quite at a distance from the mind of monoculture that would rule in a later era. And yet the early 1900s saw decisions with long-term consequences in that specialization increasingly became the rule at academic institutions, replacing a system where academics were expected to cover the entire spectrum of agricultural sciences. A plant breeder, Kurt vom Rümker, played a crucial role in the process: in a confrontation that became legendary in agricultural circles, he confronted Friedrich Althoff, the mastermind of Prussian academia, with his "firm conviction that there is no longer a single person who can cover the entire field of agricultural science, given the present volume of expert literature."[15] From such a perspective, specialization was a sheer necessity, an inevitable by-product of academic growth, and yet there was more to this trend, at least from a long-term perspective. After all, the narrow minds that defined the German world of monoculture came from specialized disciplines, often fighting spectacular battles with those who embraced a more holistic agricultural vision. It is rather obvious in the twenty-first century that narrow specialization and fragmentation of the agricultural knowledge base would have detrimental consequences, but it is crucial to note that this is more than the wisdom of hindsight. The repercussions of these trends could already be felt in the 1920s – an underrated decade in the history of German agriculture.

Decisive Years: The Interwar Period

The difference between modern agriculture and its predecessor is, if anything, a dramatic one. Among the many challenges that this implies for historians of agriculture, one is of particular importance here: the temptation to juxtapose "traditional" and "industrial" modes of production, and then go on to tell the story of how one got from the one system to the other. Few things are easier to criticize than teleologies, and yet they have their inherent charms for times of radical change. Of course, opinions differ widely on whether the transformation of agriculture was a good thing, but the basic idea that there were two distinct modes of production, and that one rose and one disappeared, permeates many a narrative, relegating crises and backlashes on the way to the status of second-rate issues. Maybe the path from traditional to industrial farm production was not smooth, but in the end, it is this path, and not the crisis, that counts the most.

On this background, it may be rewarding to stress the inherent instability of the project of monoculture. Problems were built into the project from the very beginning, and they did not relent over time, as weeds and pests, soil exhaustion and erosion, uneven load on machines labor troubles, and fluctuations of price and demand are permanent challenges for any agricultural en-

[14] Paul Wagner, *Stickstoffdüngung und Reingewinn* (Berlin, 1906), 24.
[15] Kurt von Rümker, *Mein Leben* (typewritten manuscript, Berlin, 1936), 226.

terprise that focuses on one plant only; the best that monocultures can achieve is keeping the numerous problems at bay. With that, what appeared to be a one-way street towards modern agriculture was really an endless string of problems and battles. It is crucial not only to acknowledge the existence of crises but also to see that they were far more than crests of foam on the big wave of agricultural change: they defined the path towards monoculture, and the outlook that it would take. Two examples, the propaganda for mineral fertilization and the introduction of corn into German agriculture, may illustrate this point.

For reasons of space, the present author shall dispense with extensive remarks on why mineral fertilization is important for intensive, industrial-style agriculture. Intensive use of soils requires some kind of way to replace the nutrients that go away with the commodities, and mineral fertilizers had long emerged as an important part of German agriculture in the 1920s. As early as 1800, a purportedly "complete overview" of artificial fertilizers listed no less than 45 products.[16] However, the topic gained a new urgency during World War One, when Germany, cut off from food and fertilizer imports through the Allied blockade, exploited its agricultural soils recklessly in order to forestall starvation. However, the war also produced a remedy of tempting simplicity. Shortly before the war, Fritz Haber and Carl Bosch had invented a process to produce ammonia from atmospheric nitrogen, and since ammonium is also a valuable ingredient of explosives, the chemical industry had built huge production capacities which were without use after Armistice Day.[17] What better way, then, to solve the agricultural crisis than to restore soil fertility through massive doses of ammonium fertilizer? With unprecedented intensity, scientists, officials, and advisors were preaching the gospel of mineral fertilization.

Unfortunately, the universal panacea did not work as planned. Yields per acre stayed below prewar levels for years. For example, the average rye and barley harvest for the years 1925-27 was only 81 percent that of the years 1911-13; the corresponding figure for winter wheat was 82 percent.[18] Furthermore, farmers who invested heavily into mineral fertilizer were not only making a bad investment – they were also damaging their own soils. In many places, using great quantities of ammonium led to soil acidification, a trend that was worrisome as acid soils constrain the growth of numerous important crops.[19] To be sure, it was possible to save acid soils through liming, but that method was time-consuming and costly. Furthermore, the failed experiment with massive fertilizer doses produced a wave of distrust among farm practitioners: why

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[16] Robert Somerville, *Vollständige Uebersicht der gewöhnlichen, und mehrerer bisher minder bekannten Dünge-Mittel und deren Würksamkeit* (Leipzig, 1800).

[17] For this story, see Margit Szöllösi-Janze, *Fritz Haber 1868-1934. Eine Biographie* (Munich, 1998), and Vaclav Smil, *Enriching the Earth. Fritz Haber, Carl Bosch, and the Transformation of World Food Production* (Cambridge, Mass. and London, 2001).

[18] Calculated after Max Hoffmann, Otto Nolte, *Düngerfibel. Ein Leitfaden zu der Düngertafel der D.L.G.* (Berlin, 1929), 144.

[19] The authoritative treatise on the topic was Hubert Kappen, *Die Bodenazidität nach agrikulturchemischen Gesichtspunkten dargestellt* (Berlin, 1929).

should they rely on a narrow chemical approach to cure a problem that resulted from, well, a narrow chemical approach? "Agrochemistry lost its credit in wide circles of the population," Friedrich Merkenschlager of the Federal Agency for Agriculture (*Biologische Reichsanstalt*) noted in 1933.[20] In fact, Merkenschlager argued with some justification that the acidification crisis provided an object lesson for "the fate of specialism": in his view, narrow specialization of research was "destroying the biological view in general."[21]

As so often, insult came to injury. Since Rudolf Steiner taught a "course on agriculture" in 1924, anthroposophists were practicing a new type of "biodynamic" farming that refrained from mineral fertilizer use altogether.[22] But the issue soon moved beyond anthroposophic circles, as farmers, led astray by agrochemistry, showed great interest in alternative fertilizing methods. The dubious intellectual credentials of anthroposophy quickly became a second-rate issue. In his sales pitch for biodynamic farming, an estate owner from Westphalia stressed "that the methods are not generally new; rather, they loop back to the procedures of our forefathers."[23] Biodynamic farmers were relying on manure for fertilizing, thus drawing on the interplay between livestock and feed production that agriculturalists had been preaching incessantly since the early 1800s.[24] However, that made the case for agrochemistry even more tricky: using manure was arguably more difficult and time-consuming than using mineral fertilizer, but there was no doubt that it worked.

However, the philosophy of anthroposophy comprised some dubious elements from a scientific worldview – for instance, a reliance on so-called "astral powers" –, and agrochemists gladly seized the opportunity. An editorial note in a chemistry journal lambasted biodynamic farming for "false teachings", "pseudo-science", "dilettantism", and "a fanaticism reminiscent of the Dark Ages", and that was no exception.[25] Even use of force was not beyond thought: after the Nazi's seizure of power, authors openly called for a crackdown on those "charlatans", the start of a circuitous career in Nazi Germany that would eventually make biodynamic farming temporarily illegal, favored by top Nazis, and accomplice to genocide.[26] As the net effect of this aggressive posturing, contacts between conventional and biodynamic farming were essentially taboo for more than half a century, and biodynamic farming, and alternative farming in general, remained confined to a small group of enthusiastic and idealistic practitioners. Furthermore, by chastising

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[20] Friedrich Merkenschlager, "Zeitkrise und die sogenannte 'Biologisch-dynamische Düngung'," *Natur und Kultur. Monatsschrift für Naturwissenschaft und ihre Grenzgebiete* 30 (1933): 123.

[21] Ibid.

[22] On the origins of biodynamic agriculture, see Gunter Vogt, *Entstehung und Entwicklung des ökologischen Landbaus* (Bad Dürkheim, 2000).

[23] Staatsarchiv Münster Landwirtschaftliche Kreisstellen no. 698, newspaper article of January 12, 1931.

[24] Cf. Stefan Brakensiek, "Das Feld der Agrarreformen um 1800," Eric J. Engstrom/Volker Hess/Ulrike Thoms (eds.), *Figurationen des Experten. Ambivalenzen der wissenschaftlichen Expertise im ausgehenden 18. und frühen 19. Jahrhundert* (Frankfurt, 2004), 101-122

[25] *Chemiker-Zeitung* 58 (1934), 245.

[26] For the quote, see O. Flieg, "Hände weg von unseren bewährten Düngemethoden!" *Die Umschau. Illustrierte Wochenschrift über die Fortschritte in Wissenschaft und Technik* 37 (1933): 715. For the complete story, too complicated to be told here, see Uekoetter, Wahrheit, 232-243, 268-9.

biodynamic farming and juxtaposing it to reputable scientific agriculture, the agrochemical establishment made straying from its teachings risky, and that left a defining mark on the trajectory of agricultural knowledge. After all, the biodynamic approach implied a broad and arguably holistic view on the interplay of forces on the farm, whereas agrochemistry offered a narrow focus on the nutrients, basically seeing the soil as a mere temporary storage for chemicals on the way from the factory to the crop. It was the victory of a simple and resource-intensive approach over a complicated and sophisticated one, and that may be a hint for a general history of monoculture: in the beginning, and *only* in the beginning, intensive agriculture looks amazingly simple.

To be sure, agrochemistry rebounded not only due to its vigorous response to the biodynamic challengers. A key part of their resurgence was that agrochemists became ever more ready to provide exact instructions for fertilizer use, thus fulfilling exactly the kind of need that Wagner had mocked as a "silly request" – a perfect illustration of Theodore Porter's argument in *Trust in Numbers* that disciplines embrace quantification primarily in times of crisis, seeking to regain credibility through purportedly "exact" figures.[27] However, the more pertinent issue with regard to the overarching topic is that a growing reliance on mineral fertilizer did in no way mandate a path towards monoculture. To be sure, it made German agriculture *ready for* monocultures that exhaust the soil far more than balanced crop rotations, but it did not make them inevitable. Most of the crops in use in the early 1900s were not self-tolerant, meaning that they could not be planted continuously without severe repercussions. But as it happened, the German farming community came to experiment with a self-tolerant neophyte in the 1920s that would eventually become the pillar of the German style of monoculture: corn.

It is illustrative of the improvised nature of monocultures that the rise of corn occurred quite independent of the struggles over mineral fertilizer use. The main link was that the Great War figured prominently in both stories, as it demonstrated the hazards of the German dependence on agricultural imports. As a response, autarky emerged as a key theme of agricultural research, and animal feed was one of the most pressing issues in that respect. Before World War One, Imperial Germany had imported about a third of its animal feed from abroad, making it the biggest importer of feed in the world.[28] However, with the collapse of world markets and the reparation burden of the defeated Germany, solving the feed problem via globalization was no longer an option. Thus experts came to search for ways to boost feed production per acre, and new crops were a key option in this respect.

Corn was not foreign to European agriculture, but it had traditionally played a marginal role in Germany. In 1893, corn occupied only 4,500 hectares in Germany, mostly exceptionally warm

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[27] Theodore M. Porter, *Trust in Numbers. The Pursuit of Objectivity in Science and Public Life* (Princeton, 1995).
[28] Thomas Nipperdey, *Deutsche Geschichte 1866-1918. Vol. 1: Arbeitswelt und Bürgergeist* (Munich, 1990), 193.

regions in the South.[29] However, the growing interest after World War One found its expression in the foundation of a special "committee for corn" within the renown German Agricultural Society (*Deutsche Landwirtschafts-Gesellschaft*, or DLG) in 1925.[30] In a way, this was a classic solution, as committee work had been a mainstay of DLG activities since its foundation in the 1880s, but something was new about the "committee on corn": it was the first committee that focused on a single plant. The DLG had heretofore favored a division of labor along the lines of academic specialization, with plant breeding and seed production, pest control, or fertilization falling into the purview of distinct committees. However, the neophyte under discussion was very different from the familiar plants of Central Europe: it looked different, grew later in the farm year, and required new systems of preservation, to mention just a few of the challenges. Most of all, the new plant required a systemic approach, as it was clearly insufficient to solve the problems one by one. In order to cultivate corn successfully, the experts had to combine the different innovations into one holistic system of production – just at the time when systemic thinking came under pressure in the wake of academic specialization!

The committee on corn was thus up against a dominant trend of its time, and – to cut a long story short – it did not make an impressive showing. After four years, the committee could report no more than three essays, two public meetings and one trip report.[31] It is also indicative of a certain cluelessness that the committee went on a field trip to Romania and Hungary shortly after its foundation: neither country was prominent on the mental map of agricultural scientists in Germany.[32] In fact, there are some indications that the committee never really had a full grasp of the overall challenge that corn implied for German farmers. In an essay of 1936, the committee's chairman, Hans Buß, proclaimed "clarity in all important technical questions."[33] Apparently, Buß had not yet understood that a blueprint for corn would need to be more than a compilation of individual solutions: the crucial challenge was to develop a comprehensive vision that merged the different facets into a balanced system of corn production. However, this synthesis was nowhere in sight, and corn remained a marginal plant as a result. To be sure, the Nazis conducted a mas-

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[29] Thomas Miedaner, *Von der Hacke bis zur Gen-Technik. Kulturgeschichte der Pflanzenproduktion in Mitteleuropa* (Frankfurt, 2005), 115.

[30] Heinz Haushofer, *Die Furche der DLG 1885 bis 1960* (Frankfurt, 1960), 72.

[31] Cf. *Mitteilungen der Deutschen Landwirtschafts-Gesellschaft* 42 (1927): 79-82; Ruths, "Zweckmäßiger Silobau für Mais und Erfordernisse zur Gewinnung einer guten Maissilage," *Mitteilungen der Deutschen Landwirtschafts-Gesellschaft* 42 (1927): 82-86; Ludwig Niggl, "Der Maisbau vom betriebswirtschaftlichen Standpunkte aus," *Mitteilungen der Deutschen Landwirtschafts-Gesellschaft* 42 (1927): 86-89; Richard Lieber, "Praktische Durchführung und Entwicklungsmöglichkeiten des Maisanbaues in Deutschland," *Mitteilungen der Deutschen Landwirtschafts-Gesellschaft* 44 (1929): 130-135.

[32] Hans Buß, *Der Mais, eine wichtige landwirtschaftliche Kulturpflanze. Beobachtungen auf dem Gesamtgebiete des Maisbaues, der Maissilage und der Maiszüchtung in Ungarn und Rumänien und ihre Nutzanwendung auf deutsche Verhältnisse* (Arbeiten der Deutschen Landwirtschafts-Gesellschaft Heft 372, Berlin, 1929).

[33] Hans Buß, "Körnermaisbau in Deutschland. Klarheit in allen wichtigen technischen Einzelfragen," *Mitteilungen für die Landwirtschaft* 51 (1936): 67-69, 98-100.

sive campaign for corn that brought acreage to almost 60,000 hectares in 1938, but this boom collapsed as soon as the peculiar context of Nazi autarky policies was over.[34]

All in all, Germany was already on the path towards monoculture in 1945 – but it takes the wisdom of hindsight to notice that. It had conducted experiments with corn that resolved numerous issues from a technological standpoint, meaning that the post-war boom of corn could build on a certain body of experiences. It also had developed the debate over fertilization to a point where farmers were ready to go for massive doses of nutrients. Both trends were crucial for the path to industrial-style plant production: it is hard to conceive the agricultural revolution of the post-war years without a basic familiarity with corn and a readiness to use brutal amounts of fertilizer. The interwar years were decisive for the path towards monoculture, though only on an intellectual level. The actual transformation of agriculture had yet to grow into full swing.

The Landslide (figurative and real)

It is hard to overstate the extent of the transformation of Central European agriculture in the post-war years. However, one of the most amazing things about this transformation was that very few things were actually new in the 1950s and 1960s. The case of corn, which was known all over Germany since the 1920s, was by all means typical: the key ingredients of the post-war agricultural revolution – tractors, mineral fertilizer, commercial seeds, etc. – existed long before the great transformation actually happened. The post-war years were notably poor on fundamental innovations, and that may be an important hint as to the underlying causes. The crucial thing was not the knowledge that farmers had or won – the crucial thing was the knowledge that was *missing*.

The massive boom of corn production since about 1960 provides a case in point. First of all, it happened unexpected: incidentally, a German scientist published a synthesis on corn in 1960 that focused on a broad range of countries from the USA to South Africa without ever mentioning the plant's potential for Central Europe – in retrospect, an omission of almost touching naiveté.[35] Second, the boom ignored textbook lessons to a significant extent, with the most consequential issue being that of crop rotations. "Never plant corn after corn", Hans Buß had warned in the 1930s, and the 1960s handbook by Gustav Aufhammer allowed no more than two harvests in a row – in reality, corn became the emblematic plant of monoculture in Germany.[36] Third, the up-

[34] Johannes Zscheischler et al, *Handbuch Mais. Umweltgerechter Anbau, wirtschaftliche Verwertung* (4th edition, Frankfurt et al, 1990), 20;

[35] Carl Schrimpf, *Mais. Anbau und Düngung* (Bochum, 1960).

[36] Hans Buß, Richard Lieber, *Deutscher Mais auf deutschem Boden. Erfahrungen und Anregungen in 1000 Worten und 100 Bildern* (Berlin, 1937), 12; Gustav Aufhammer, *Neuzeitlicher Getreidebau* (2nd edition, Frankfurt, 1963), 137.

swing in scholarly interest that went along with the boom of corn was notably selective: most of the researchers were either seed experts, economists, or engineers who were perfecting the fully mechanized production chain. A broad multidisciplinary synthesis, or even a holistic vision that brought together the different aspects of corn production, was nowhere in sight.

The path towards monoculture was nowhere nearly science-based, but essentially occurred as a confluence of three different trends: the rise of large-scale animal production, corn, and liquid manure technology. The latter is an interesting topic in itself, as liquid manure – one of the most controversial features of industrialized farming in Germany – has a background that is environmentally benign: it grew as a special Alpine technology in order to fertilize pastures for milk production. When liquid manure technology moved northward in the 1950s, farmers were first using it on grasslands.[37] However, farmers eventually noticed the merits for plough land, and corn played a crucial role in the process; some observers celebrated corn as "the ideal crop for liquid manure (*ideale Güllefrucht*)".[38] Corn was not sensitive to overfertilization, unlike traditional European grains which tend to topple over if they consumed excessive doses of nutrients. Even more, corn could be used as animal feed, thus underscoring the trend towards industrial-style animal production. It would all have been great if it had not been for the massive environmental toll.

Liquid manure quickly moved from a technology of fertilization to a "technology of waste removal", as one commentator noted dryly.[39] As a result, most of the nutrients, rather than nourishing the growth of corn, ended up in the groundwater, creating grave nitrate problems. Atrazine became the second notorious pollutant associated with corn since this herbicide provided a quick fix for the notorious weed problems of corn monoculture; after decades of excessive use, groundwater contaminations were so high that its use was banned within the Federal Republic of Germany in 1991.[40] Since corn leaves much land without vegetation cover, erosion emerged as another serious issue. In fact, this problem could have been far worse if it had not been for the benign character of many Central European soils which tolerate a great deal of abuse, at least for some time. The environmental repercussions were so serious that after three decades, even the handbook on corn cultivation (*Handbuch Mais*) warned of excesses in corn monoculture: "The

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[37] I have discussed this story extensively in Frank Uekötter, "Das flüssige Gold der Landwirtschaft," Christian Kleinschmidt (ed.), *Kuriosa der Wirtschafts-, Technik- und Technikgeschichte. Miniaturen einer "fröhlichen Wissenschaft* (Essen, 2008), 77-81.

[38] Günter Spielhaus, "Gülle paßt gut zu Mais," *Landwirtschaftliches Wochenblatt Westfalen-Lippe* 137:13 (March 27, 1980), edition B: 26.

[39] Jürgen Rimpau, "Düngung und ökologische Auswirkungen. Berichterstattung," *Mit welcher Düngungsintensität in die 90er Jahre? Vorträge und Ergebnisse des DLG-Kolloquiums am 13. und 14. Dezember 1988 in Bad Nauheim* (Frankfurt, 1989), 58.

[40] Carina Weber, "Pestizide," Agrarbündnis (ed.), *Landwirtschaft 1993. Der kritische Agrarbericht* (Rheda-Wiedenbrück, n.d.), 147.

logic of 'more corn – more animals – more liquid manure – more income', while self-evident in economic terms on first sight, clearly has led us into a dead-end street."[41]

In 1971, a leading advocate of corn production noted that the plant's boom in Germany and elsewhere was due "mainly to the recent results of scientific research in numerous agricultural disciplines."[42] However, that was half the truth at best. To a significant extent, the boom was due to simple "rules of thumb": overfertilization and indiscriminate use of herbicides. These simple solutions allowed corn cultivation to expand until the environmental consequences became too grave to ignore; in other words, excessive resource use became the functional equivalent of deficient knowledge. Corn monoculture was clearly not science-based in a comprehensive sense, as scrutiny from researchers remained confined to selected issues: seeds, machines, and business plans. For other issues, the dominant practice was reminiscent of George Orwell: ignorance was strength.

Conclusion: Making Sense of Monoculture

At the risk of stating the obvious, the previous remarks do not intend to provide more than a rough overview of the German path towards corn-based monocultures. Instead of giving an in-depth view, the idea was to use corn as a case study to reflect on the broad contours of what one day might become a global history of monoculture. In order to stimulate discussion, the following points shall summarize my current state of reflection:

- The rise of corn monocultures did not follow a scientific blueprint, or any blueprint at all; in fact, the boom took place in the wake of spectacular *failures* to develop comprehensive approaches to corn production. This monoculture evidently grew from below, with selective input from science at best. Given that the case study happened in a country with a strong agricultural science network, one might wonder whether are monocultures are really made – or whether they simply happen.
- The introduction argued that monocultures should be seen as a set of independent processes that coexist and interact in the same spot. As on the case under discussion here, a number of divergent rationales stand out: the superior ability of corn to use sunlight for photosynthesis; the advantages of corn as animal feed; crop rotations; use of specialized machines; the hunger for nutrients; weed problems. All these rationales were autonomous,

[41] Zscheischler et al, Handbuch Mais, 107.
[42] Paul Rintelen, "Vorwort," Paul Rintelen (ed.), *Mais. Ein Handbuch über Produktionstechnik und Ökonomik* (Munich, 1971), V.

and yet no system of corn production was feasible in the long run if it ignored one of these rationales.

- In short, there was a need for some kind of synthesis. However, the divergent rationales of corn monoculture were not resolved in anything like a holistic vision. Instead, some of these rationales received prime attention while others were taken care of with resource-intensive makeshifts and rules of thumb (until the environmental consequences came back with a vengeance). Even more, this shift for certain rationales and against others occurred quite suddenly around 1960 – a "tipping point" that may exist for other monocultures as well.
- For two reasons, science emerges as a precarious actor in the story at hand. First, it proved unable to provide a comprehensive vision of corn production due to the burden of growing academic specialization. Second, farmers used even the body of scientific knowledge selectively, tending to favor rationales that quickly boost productivity and more or less ignoring issues of long-term sustainability. The knowledge base of monoculture was, at its core, a cannibalized kind of science.
- If we look at the mind of monoculture, what we find is usually a hybrid: a mixture of existing practices, scientific results, and innovations in the field. Inputs came from many sides, with their combination often having an improvised and even accidental character. Ecologically as well as cognitively, monocultures emerge as unstable entities, and they mature only to a certain extent. The stability of monocultures is a relative one.
- Planting corn is a complicated endeavor, and yet it looked enticingly simple when things were starting in the 1920s and when things took off in the 1960s. In the latter case, the allure of simplicity even stayed for several decades: corn was the perfect plant for farmers busy mastering the intricacies of factory farming. Thus, it seems rewarding to pursue this issue more broadly: exactly when does monoculture look simple, for whom, and for how long? In short, what exactly is the magic of one – and why does it persist so long in the example at hand?
- Interestingly, there were boosters who emphatically noted how simple things were, like Justus von Liebig. However, there seems to be no direct way from these promises of simplicity to the kind of simple approaches that came to dominate. In fact, they seem to be largely unconnected: the ignorance inherent in monoculture was a silent affair.
- Crucial as it is, knowledge is not indispensable for the project of monoculture: resources, machines and human labor can provide functional equivalents. The wastefulness of corn monocultures was not a mere side effect – it was part of the intellectual program. How-

ever, it should be clear that such an approach has enormous costs, and not only in monetary terms.

- The expansion of corn ran parallel with the rise of service providers in agriculture – by 1990, most of the work was done by external machines and personnel.[43] In fact, the division of labor, and the division of worldviews and interests that go along with them, may emerge as key issues in a history of monoculture.
- That brings up a key issue: communicating about monoculture and its problems. My impression is that this kind of communication was the easiest from the outside in: protest against corn monocultures was overwhelmingly coming from those uninvolved in the business of agricultural production. But exactly where are the obstacles to an open discussion that gets the different actors involved?
- The study of monocultures calls for an approach on the longue durée: any understanding of monoculture that focuses on small time spans only is bound to produce misleading results. In 1970, corn monoculture was essentially a great thing – in 1990, it looked like the original sin of industrial-style agriculture. The current rage over energy crops may signal yet another swing of the pendulum.
- In a way, monocultures flourish with a mindset reminiscent of George Orwell's doublethink: on one level, the problems inherent in monoculture are plain; but on another one, the "magic of one" reigns supreme. One can barely say that the repercussions of corn monoculture were unanticipated – they were simply not taken note of for quite a while!
- Finally, it seems worthwhile to reflect on where this case study is atypical for monocultures worldwide. For instance, does it matter that corn was produced not for men but for animals, making quality a second-rate issue? Furthermore, the expansion of corn production was driven by technological "economies of scale", as expensive machines were calling for a satisfactory load factor. It remains to be seen whether similar technological imperatives existed for other monocultures that were less dependent on a fully mechanized production chain. Finally, corn was never an iconic plant in Germany – no equivalent to banana cultures or rice paddy romance. For insights on the culture of monoculture, the present author will need to look elsewhere.

[43] Zscheischler et al, Handbuch Mais, 259.