Replenishing the soil: food, fertilizer and soil science in Occupied Japan (1945-52)

Abstract

Environmental scientists and activists in the early twenty-first century have identified productive, healthy soils as a key factor in feeding a rapidly increasing global population and mitigating climate change. This article argues that serious food shortages in Japan following its defeat in 1945 caused the fertility of its soils to become a pressing issue for the Allied Occupation (1945-52) and one seen as central to the success of democratization. The prospect of famine in the cities in 1946 and 1947 and associated political unrest justified urgent imports of food from the US, causing much resentment among its allies, who questioned the seriousness of the food supply crisis in Japan. The Occupation's Natural Resources Section worked to reduce Japan's dependence on food imports by surveying Japan's soils and recommending their rapid augmentation with chemical fertilizers, the manufacture of which had practically ceased during the war. The US imported nitrogenous fertilizer to supplement inadequate domestic output and provided phosphate ore (for superphosphate fertilizer) from Florida in addition to encouraging Japanese mining operations on Angaur Island, formerly part of the Japanese empire. The latter generated conflicts with the natives of the island, the local US naval command and the Australian government. Such tensions demonstrate the many and varied facets of the 'fertilizer problem', which was seen as pivotal to food supply and economic recovery. Major imports of agricultural commodities from the US after 1952 reflected its Cold War alliance with Japan. Likewise, significant transfers of technology contributed to a steep increase in the use of agricultural chemicals, causing the fertilizer problem to become a pressing environmental one by the 1990s.

Key words: chemical fertilizer, soil science, food supply, Allied Occupation of Japan, economic recovery, Cold War

The productivity of Japan's soils was an issue that quickly came to the fore in the wake of Japan's defeat in the Asia-Pacific War and its military occupation by the Allied powers, principally the US. The priority given by American reformers to surveying Japan's soils and rapidly increasing production of chemical fertilizers reflected the food supply crisis they had to contend with from the outset and its perceived implications for the success of democratization. In the early twenty-first century protecting soils from a range of threats, including excessive chemical inputs, is increasingly seen as the key not only to feeding a rising global population but also to combating anthropogenic climate change as soils act as a carbon store. As one recent publication puts it, soils are 'Underfoot…Unseen…Ignored' and yet are vital for the ecosystems on which we depend.[1] They are similarly invisible in the historiography of the Occupation of Japan despite their importance for understanding its dynamics, particularly in relation to the food crisis that preoccupied it from 1945 to 1947. This necessitated urgent imports of food and fertilizer (or its raw material) and the priority given to restoring Japan's own productive capacity for chemical fertilizers that were used alongside commercial organic ones and farm manures. This article argues that the Occupation accelerated a rebalancing of the fertilizer mix towards an over-reliance on chemical inputs.

There is now a consensus among those concerned with soil conservation that organic fertilizers are preferable to chemical ones, because they provide more gradual release of nutrients, reducing loss by leaching, and they enhance soil structure despite the lower concentration of nutrients they provide. As one Japanese authority puts it, 'the use of organic fertilizers helps improve soil properties'.[2] However, such environmental considerations only

[1] G. Churchman and E. Landa, Introduction, in Churchman and Landa (eds), *The Soil Underfoot*, pps xiv and xv (Boca Raton, FL: CRC press, 2014).
[2] M. Koshino, 'The use of organic and chemical fertilizers in Japan', Food and Fertilizer Technology Center, Extension Bulletin No. 312, November 1990, foreword.

really came to the fore with the publication in 1962 of Rachel Carson's landmark text, *Silent Spring*, a damning and compelling critique of chemical pesticides. Her approach was an ecological one that captured the delicate, fragile 'web of interwoven lives' that makes up the 'soil community'.[3] Before the 1960s, and particularly in the immediate aftermath of the Second World War amidst scarcity and dislocation, more immediate concerns prevailed, when those responsible for maximizing crop yields confidently resorted to such industrial remedies as inorganic fertilizers. Quickly ramping up production of chemical fertilizers to replenish what were considered to be depleted soils became a leading priority for the Occupation, the very poor rice harvest of 1945 blamed on a dearth of such chemicals as well as poor weather and a shortage of labour.[4]

Following some brief attention to the neglect of this subject in the historiography of the Allied Occupation of Japan, this article then explores the food supply crisis, the essential backcloth to the 'fertilizer problem'. The latter preoccupied those Americans staffing the Soils and Fertilizer Branch (SFB) of the Agriculture Division in the Natural Resources Section (NRS) of the Occupation Headquarters (GHQ SCAP).[5] Its members argued strongly that the answer to Japan's food problem lay in large part in the soil and replenishment of those nutrients essential to plant growth, namely nitrogen (N), phosphorus (P) and potassium (K). The article explores the operation and findings of the NRS's reconnaissance soil survey, and then considers the factors that impeded the planned increase in the production of key chemical fertilizers, particularly nitrogenous ones. Its final section examines the legacies of the

[3] Rachel Carson, *Silent Spring*, p. 63 (London: Penguin, 1962).
[4] *Summation of Non-Military Activities in Japan*, No. 8, May 1946, p. 60.
[5] SCAP is the acronym for the Supreme Commander for the Allied Powers and is used as shorthand for both General Douglas MacArthur himself and for the Occupation organization over which he presided.

Occupation's policies around soils, fertilizer and food, assessing the environmental impact of the strong promotion of inorganic chemicals as the key to increasing crop yields. Also explained is how contentious food aid gave way to large-scale imports of US agricultural commodities and how the chemical industries, including fertilizer, were transformed by technology transfers, principally from the US. Both took place in the context of the Cold War, which fostered close ties between the US and Japan. Steven Fuchs contends that these began with the food crisis, the emergency food aid laying 'the foundation for the Pacific Alliance'.[6]

Environmental histories of the Occupation

Only recently have historians of wartime and Occupation era Japan started to enrich their understanding of this formative period in Japan's development by exploring topics that fall under the rubric of environmental history.[7] This fits with a larger historiographical context of delayed recognition of Japan's importance to this approach. A recent path-breaking study of Japanese environmental history admits that 'It is hard to deny that the environmental turn has been a latecomer to Japan studies, particularly historical studies',[8] and this despite Japan's history 'represent[ing] all of the major environmental history issues of the modern world and many from the pre-modern world…'.[9] Environmental historians seem to prefer the large

[6] Steven Fuchs, 'Feeding the Japanese: food policy, land reform, and Japan's economic recovery', in Mark Caprio and Yoneyuki Sugita (eds), *Democracy in Occupied Japan*, p. 26 (London: Routldege, 2007).
[7] The most popular topic has been fisheries and whaling. Examples include Jacobina Arch, 'Whale meat in early postwar Japan: natural resources and food culture', *Environmental History*, 21: 3 (2016): 467-87; William M. Tsutsui, 'An empire reborn: the Japanese fishing industry during the Occupation', in Thomas French (ed.), *The Economic and Business History of Occupied Japan*, pp. 75-94 (London: Routledge, 2018).
[8] Brett L. Walker, 'Preface', in Ian Jared Miller, Julia Adeney Thomas and Brett L. Walker (eds.), *Japan at Nature's Edge: The Environmental Context of a Global Power*, p. xiii (Honolulu: University of Hawai'i Press, 2013).
[9] Philip C. Brown, 'Environmental history', in Sven Saaler and Christopher W. A. Szpilman (eds.), *Routledge Handbook of Modern Japanese History*, p. 391 (Abingdon: Routledge, 2018).

canvases presented by China, the Soviet Union or the United States, and may also have been swayed by Japan's apparent cultural predisposition to respect and value nature.[10]

Historians of the early postwar period in Japan have paid scarcely any attention to a dedicated team of American scientists in the Agriculture Division of NRS, who worked on soil science and fertilizer requirements in order to improve food supply. This reflects the marginalization of the NRS in studies of the Occupation period, largely due to its staff being seen more as technicians than reformers, conducting research in the field and compiling reports that informed policy rather than leading the process.[11] This is to misunderstand the essential nature of the Occupation as first and foremost an exercise in foreign military rule with the primary responsibility of ensuring its efficacy. Key to that was preventing disease and unrest, both of which were threatened by the serious food shortages besetting Japan after its surrender in 1945. Another relevant factor is the broader neglect of soils in environmental histories. Whereas soil science is now an established subject, largely as a result of the urgent challenge of global warming and pressures on food supply, there are still relatively few studies of its history, except in relation to agriculture, fertilizers and crop yields. As regards Japan, there is a dearth of material on the history of soil science.[12]

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[10] *Ibid*., p. 390.

[11] Uchida Shun'ichi, Kawasaki Kyôshi & Kako Saburô (eds), *Nihon no fukkô to tennen shigen seisaku* [Japan's Recovery and Natural Resources Policy], preface (Tokyo: Shigen Kyôkai, 1986).

[12] The reader may find occasional articles with a historical focus in *Soil Science and Plant Nutrition*, published in English by the Japanese Society of Soil Science and Pedology, and its Japanese-language sister journal *Nihon Dojô-Hiryôgaku Zasshi*. Examples from the former include Yutaka Kamoshita, 'Soils in Japan', 5 (1959): 84-94; Hideaki Hirai and Tadao Hamazaki, 'Historical aspects of soil classification in Japan', 50 (2004): 611-622. Typical of the predominantly scientific focus of articles is K. Minami, 'Recent trend of nitrogen flow associated with agricultural production in Japan', *Soil Science and Plant Nutrition*, 47 (2001): 157-166. Useful general studies of Japanese agriculture that focus on soils and fertilizer are T. Ogura, *Agricultural Development in Modern Japan* (Tokyo: Fuji, 1970) and I. Yamane, *Kôchi no Dojôgaku* [Soil Science for Agricultural Land] (Tokyo: Nobunkyo, 1981). See also M. Okazaki and K. Yonebashi, 'The evolution of paddy rice and upland cropping in Japan with reference to soil fertility and taxation', in G. Churchman and E. Landa (eds), *The Soil Underfoot*, pps 213-220 (Boca Raton, FL: CRC press, 2014).

Americans involved in the Occupation conducted economic studies of food management and the Japanese economy that touched on fertilizer,[13] but few studies since have explored the importance of night soil and other organic fertilizers, together with their chemical counterparts, for premodern and Imperial Japan.[14] William Tsutsui touched on the subject in a wide-ranging essay on the environmental history of the wartime period.[15] Likewise, Mark Metzler considers fertilizers in the context of 'a metabolic crisis' during the immediate postwar period, focusing on energy flows in relation to food, fuel, fertilizer, basic materials and transport. He highlights Japan's growing dependence from the 1930s on chemical fertilizers, and the factory processes that created them, and explores the shattering impact of the war years on early postwar production.[16]

Forestalling famine

A number of factors combined in the opening months of the Occupation to produce a sense of crisis over food supplies and the prospect of famine. As a result of a shortage of fertilizer and serious typhoons and floods in the autumn of 1945 the rice harvest was the worst since 1910,

[13] Bruce F. Johnston, *Japanese Food Management in World War II* (Stanford: Stanford University Press, 1953); J. B. Cohen, *Japan's Economy in War and Reconstruction* (Minneapolis: University of Minnesota Press, 1949).
[14] T. Higuchi, 'Japan as an organic empire: commercial fertilizers, nitrogen supply, and Japan's core-peripheral relationship', in B. Batten and P. C. Brown (eds), *Environment and Society in the Japanese Islands*, pp. 139-57 (Corvallis: Oregon State UP, 2015); David L. Howell, 'Fecal matters: Prolegomenon to a history of shit in Japan', in Miller, Thomas and Walker (eds), *Japan at Nature's Edge*, pp. 137-51. Susan Hanley has written about nightsoil in relation to urban sanitation – see 'Urban sanitation in Preindustrial Japan', *Journal of Interdisciplinary History*, 18: 1 (1987): 1-26. For chemical fertilizers, see Barbara Molony, *Technology and Investment: The Prewar Japanese Chemical Industry* (Cambridge, Mass.: Harvard University Press, 1990).
[15] William Tsutsui, 'Landscapes in the Dark Valley: Toward an Environmental History of Wartime Japan', *Environmental* History, 8:2 (2003): 294-311.
[16] Mark Metzler, 'Japan's postwar metabolic crisis', in Thomas French (ed.), *The Economic and Business History of Occupied Japan*, p. 37 (London: Routledge, 2018).

amounting to just 60% of the prewar norm.[17] Moreover, the loss of Japan's empire, from which it had imported foodstuffs accounting for around 15-20% of consumption, compounded the problem of shortages. To make matters worse, established systems of food collection and distribution were disrupted by the administrative confusion that followed Japan's surrender, a slackening of control which served to fuel the rampant black market. The latter placed farmers or 'self-suppliers' in a highly advantageous position in terms of access to food, whereas urban residents found it increasingly difficult to eke out an existence. These problems produced 'food crises…during the first two years of the Allied occupation…more severe than any of Japan's wartime shortages'.[18]

This was the context for imports of food from the US – emergency relief that was controversial among Americans at home, who tended to be unsympathetic to their wartime foe,[19] and among the US's allies, who felt that Japan was receiving preferential treatment at a time of global cereal shortage. In 1947 a majority of the eleven members of the Far Eastern Commission,[20] a body formally accorded a policy making role, objected to Japan receiving food aid on the grounds that the diet of people in many Asian countries devastated by Japan's wartime aggression was 'inferior to that of Japanese'.[21] The politics of food aid thus preoccupied MacArthur and his section chiefs with responsibility for natural resources, economic recovery and public health. Together they endeavoured to make a case for imports

[17] John Dower, *Embracing Defeat: Japan in the Wake of World War II*, p. 93 (New York: W. W. Norton, 1999).
[18] Johnston, *Japanese Food Management*, p. 213.
[19] See A. Bentley, *Eating for Victory: Food rationing and the politics of domesticity*, pp. 150-1 (Urban, Ill.: University of Illinois Press, 1998).
[20] The eleven countries represented were the US, the USSR, the Republic of China, Britain, Australia, Canada, France, India, the Netherlands, New Zealand, and the Philippines.
[21] Telegram from Acting Secretary of State to the Acting Political Adviser in Japan, 11 March 1947, *Foreign Relations of the United States 1947, Volume 6, The Far East*, p. 373.

that initially invoked the spectre of famine and the disastrous 'disease and unrest' that would follow in its wake.

Food missions were sent from Washington DC to Japan in 1946 and 1947 to verify the accuracy of the Occupation's claims, to advise their colleagues in Tokyo about how best to maximize indigenous resources and so to arrive at minimal estimates for food imports that would placate domestic critics and resentful allies. A special Japan food mission, led by Colonel Raymond Harrison, visited Japan in March 1946 and reported to the US secretaries of agriculture and state that a minimum of 200,000 tons of grain a month was needed for April, May and June 1946 to avert 'serious food shortages in deficit areas'.[22] Hard on its heels came the Famine Emergency Committee, chaired by ex-president Herbert Hoover, which confirmed the findings of Harrison's mission. In February 1947 Colonel Harrison was back in Japan again, this time at the head of a food and fertilizer mission that was more critical of the Japanese government's commitment to maximizing indigenous food stocks and the degree to which it was being properly held to account by GHQ SCAP. Nevertheless, the mission did not question the need for food imports from the US, rather the wrangling was about their scale.[23]

The discussions that arose from these missions tended to focus chiefly on average per capita caloric intake, particularly by urban residents, who were rightly identified as the ones most at risk of 'acute malnutrition' or starvation. In terms of what was needed to meet this threat,

[22] Outgoing message, from: SCAP; to: WARCOS [National Diet Library, hereafter NDL, Tokyo, fiche ESS (C) 00095].
[23] A more detailed analysis of the politics of food aid is provided by Christopher Aldous, 'Contesting famine: hunger and nutrition in Occupied Japan, 1945-52', *Journal of American-East Asian* Relations, vol. 17, no. 3, 2010, pp. 230-56.

Herbert Hoover declared that his priority was cereals as they could 'furnish 85% of an emergency diet'.[24] When imports of food began arriving in large quantities in July and August 1946, the bulk of it was wheat (187,207 metric tons), flour (59,154), and maize (88,542). Although very limited amounts of rice (15,709 metric tons) had been imported since the beginning of the year, these stopped in June 1946.[25] As to where these cereal imports were directed, the Occupation's monthly summations indicate that the total ration requirement for Tokyo in July 1946 was met by imported food, as was the bulk of provision in Osaka (84.3%), Kanagawa (83.9%), Aomori (83.3%), Yamanashi (75.5%), Hokkaido (69%), Kyoto (67.6%), and Hyogo (57.6%) prefectures. The pattern that emerges is the concentration of imported food supplies in comparatively few areas, principally Tokyo, Hokkaido, Osaka, Kanagawa, Kyoto and Hyogo.[26] It was the urban populations of these prefectures, particularly the residents of Tokyo, who depended on US provision of 'rice substitutes', namely wheat, for much of their staple food rations.

Whereas the rice harvest of 1945 yielded only 5,872,000 tons, the figure for October 1946 was an impressive 9,208,000 tons. Production of sweet potatoes also increased from 3,870,000 tons to 5,515,000.[27] In response to the bumper rice crop, it was decided to increase the staple food ration for non-producers from 1,042 to 1,246 calories to bring 'the ration closer to the subsistence level'[28] of 1,550 calories. Nutrition surveys showed that urban consumers made up the shortfall as best they could by purchasing produce on the black market, which exposed the government's failure to rigorously control supplies of staple foods.

[24] Letter to President Truman, 13 May 1946.
[25] *Summation of Non-military Activities in Japan*, no. 12, September 1946, p. 165.
[26] *Summations*, nos 10 (July 46), p. 184, 11 (August 46), p. 183, 12 (Sept 46), p. 169.
[27] Nihon Tôkei Kyôkai [Japan Statistics Association] ed., *Nihon Chôki Tôkei Sôran* (hereafter *NCTS*), vol 2, pp, 41-43 (Tokyo: Nihon Tôkei Kyôkai, 1987) pp. 41-3.
[28] Fuchs, 'Feeding the Japanese', p. 29.

While delivery of an adequate ration on time was obviously essential for urban residents, such ambitions put pressure on indigenous supplies, as did the repatriation of around six million Japanese soldiers and civilians from wartime theatres during the first two years of Occupation. In any case, the import gap remained and so it was not surprising that the food and fertiliser mission of February 1947 called for 1,100,000 tons of food imports from the US and 'a vigorous and impartial program for collecting, distributing and rationing all available foodstuffs' to cover a shortfall of two million tons.[29] Harrison identified a number of problems impeding domestic production of food, 'by far the most important' of which was 'the shortage of commercial fertilizers'. He urged the Occupation to 'instruct the Japanese Government to intensify its efforts to complete the repair and conversion of nitrogen and superphosphate plants' to maximize production, and likewise to ensure that there was sufficient capacity to produce the sulfuric acid required by these factories.

Surveying depleted soils

As a leading economic authority observed during the Occupation, 'Japan depends more on fertilizer than any other country in the world'.[30] This was principally due to the soils of Japan being 'relatively infertile',[31] reflecting both their composition and the heavy demands made of them in terms of intensive cultivation over many centuries. Such practices as double cropping that depleted the soil of plant nutrients were not sustainable without their timely replacement by means of fertilizers, and from the 1930s inorganic chemicals were increasingly utilized alongside commercial organic fertilizers (mainly soybean cake and fishmeal), and farmyard

[29] 'Report on Food and Fertilizer Situation in Japan, Korea and the Ryukyus' by Joint War, State and Agriculture Mission, 4 April 1957, Exec Summary, 2-3, Main Report, 19-23. Accessed in NDL, Tokyo, Public Health and Welfare Section, fiche PHW 01246.
[30] Cohen, *Japan's Economy in War and Reconstruction*, p. 365.
[31] C. L. W. Swanson, 'Fertilizers and food production in Japan', *Fertilizer Review*, Sept-Oct and Nov-Dec 1947 issue, p. 1.

manures including night soil.[32] Indeed, farmers' use of chemical fertilizers rocketed from 1,420,000 metric tons in 1926 to 3,674,000 in 1937 when it peaked. The following year Japanese farmers were spreading an average of 105 pounds of such fertilizers per acre compared to 56 pounds in Germany and just 9 pounds in the US.[33] During the period 1935-37 Japan was the world's leading user of the nitrogenous chemical fertilizer, ammonium sulfate.[34] There is no doubt that chemical fertilizers along with hardier strains of rice and other crops helped food production keep pace with Japan's rising population.

During the Asia-Pacific War (1937-45), fertilizer output was 'sacrificed for war chemicals',[35] causing a steep decline in the production and associated consumption of ammonium sulfate and calcium cyanamide in terms of nitrogen, and superphosphate for phosphorus. By comparison with substantial outputs of these chemicals during the 1930s, those of inorganic potassic fertilizer were negligible. Of 67 pounds of potash applied per cultivated acre in 1938, just 14 pounds came from inorganic chemicals, 3 from organic commercial fertilizers and 50 from farm-supplied manures and night soil. The respective figures for nitrogen were more balanced – 45, 15 and 50 (a total of 110 pounds) – as were those for phosphorus – 30, 5 and 26 of a total of 61 pounds.[36] These figures demonstrate that even at a time of heavy inorganic inputs, organic fertilizers were equally or more important in terms of the plants foods they provided. From 1941 production of chemical fertilizers crashed, reflecting increasing demand for ammonia in munitions factories and Japan's dependence on external sources of phosphate

[32] Edward A. Ackerman, *Japan's Natural Resources and Their Relations to Japan's Economic Future*, p. 404 (Chicago: University of Chicago Press, 1953).
[33] Cohen, *Japan's Economy*, pp. 365-66.
[34] NRS Report No. 148, *Agricultural Programs in Japan, 1941-51*, p. 40 (GHQ SCAP: Tokyo, 1951).
[35] Cohen, *Japan's Economy*, p. 477.
[36] War Department Pamphlet No. 31-10, *Civil Affairs Guide: Agriculture and Food in Japan*, 15 July 1945, p. 109.

rock and potash that became increasingly inaccessible. Supplies of soybean cake, largely imported from Manchuria, and fishmeal that depended on a fully functioning domestic fishery likewise dropped precipitously.[37] The exigencies of war thus resulted in much greater dependence on home manures and night soil during the war years. These accounted for 86% of nitrogenous fertilizer by 1945, and around 96% and 99.5% of phosphorus and potassium respectively.[38]

These were figures sought from the Japanese government by American soil scientists, who were keen to survey and classify Japan's various soils so as to assess as accurately as possible the fertilizer needs of particular areas and crops, particularly the main staple rice. As one of them explained, understanding the 'nature and productivity of the soils of Japan' was necessary for 'the efficient distribution of commercial fertilizers'.[39] Very quickly staff of the Soils and Fertilizer Branch of NRS consulted with Japanese soil scientists in the Japanese Ministry of Agriculture and Forestry to coordinate soil studies of the entire country. As was often the case with the Occupation, the two parties had first to agree common terms as the trajectory of soil science in Japan differed from that in the US. Those in the SFB received soil maps from the Japanese that indicated that they had historically deferred to 'the old geological method of soil surveying similar to that used initially in the US'.[40] This reflected the late nineteenth-century German influence on Japanese understanding of soil, when Max Fesca advised the Agronomy Division of the Imperial Geological Survey. This German approach caused soils to be classified principally according to their geological properties or parent

[37] *NCTS*, vol 2, pp, 367-68 (Tokyo: Nihon Tôkei Kyôkai, 1987).
[38] Swanson, 'Preparation and use of composts, night soil, green manures, and unusual fertilizing materials in Japan', *Agronomy Journal*, 41 (July 1949): 275.
[39] Swanson, 'Fertilizers and food production in Japan', p. 7.
[40] *Ibid*.

materials, and the associated maps tried to 'correlate soil fertility and plant growth with geological formations'.[41] One American soil scientist contended that this emphasis on landscape and geology was understandable, given the extremely rugged landscape and steep slopes that dominated Japan's topography.[42] Put another way, Japan's terrain militated against the development of large and continuous areas of mature soil. High rainfall throughout much of Japan likewise contributed to immature and young soils by eroding weathered materials from the slopes.

However, by the 1920s Japanese studies of soil, influenced by international developments, moved away from a geological conception of soil towards one more in line with the new discipline of pedology or soil science. This had originated in Russia, when Vasily Dokuchaev represented 'soils as natural and historical bodies that had a "special character" and needed to be studied in their own right, not as part of geology'.[43] His approach was an environmental one, identifying 'a series of soil-forming factors', namely climate, vegetation, ground water, relief or slope and human activity as well as rock or parent material.[44] At the heart of pedology is the soil profile as the key unit of classification, consisting of several horizons or layers. In descending order, the main layers of a mature soil are the A-horizon or topsoil, where the humus and nutrients are concentrated, a thicker B-horizon or subsoil, and then the C-horizon or parent material.[45] Japanese pioneers of pedology, first Seki Toyotarô and then Kamoshita Yutaka, highlighted the importance of climate and vegetation for soil

[41] Hirai and Hamazaki, 'Historical aspects', p. 611; NRS Report 110-1, *Reconnaissance Soil Survey of Japan: Summary*, Tokyo, 1951, p. 20.
[42] Swanson, 'Reconnaissance Soil Survey work in Japan', *Science*, 19 September 1947, p. 257.
[43] David Moon, *The Plough that Broke the Steppes*, p. 79 (Oxford: Oxford University Press, 2013).
[44] Hirai and Hamazaki, 'Historical aspects', p. 611; Yutaka Kamoshita, 'Soils in Japan', *Soil Science and Plant Nutrition*, 5 (1959): 84-87
[45] Daniel Hillel, *Out of the Earth: Civilization and the Life of the Soil*, p. 28 (Berkeley: University of California Press, 1991).

development, and established the characteristics of the soils themselves as the basis for classification.[46] These advances were clear from an outline soil map of Japan, drawn up by Seki, and included in a book by Leopold Scheidl, *Der Boden Japan* [The Soils of Japan], published in 1937. According to Kamoshita, Japanese soil scientists were now 'eager to get a chance to re-survey the whole nation in accordance with modern, or pedological methods', but no such comprehensive survey was properly underway until the outbreak of war and was quickly frustrated thereafter.[47] Kamoshita was chief soil surveyor at the Imperial Agricultural Experiment Station at Nishigahara, Tokyo prefecture, at the end of the war, and as early as January 1946 he was consulted by the staff of the Agriculture Division of NRS about the status of soil survey units in Japan.[48]

American soil scientists of the SFB found that Kamoshita was among a small number of Japanese soil experts, who were conversant with 'the modern concept of the classification of soils into climatic soil groups' in line with American practice. However, there were too few apparently with the requisite training and experience to compile a comprehensive soil survey that could inform the Occupation's agricultural programmes.[49] Thomas Ritchie of the SFB, who supervised NRS's Reconnaissance Soil Survey (RSS) for more than four years, complained about the deficiencies of Japanese past surveys, the lack of consistency over classification schemes and terminology, and their failure to conform to models familiar to scientists in the US and Europe. As one of Ritchie's colleagues explained, 'The

[46] NRS Report 110-1, *Reconnaissance Soil Survey*, 20
[47] Yutaka Kamoshita, 'Soils in Japan', *Soil Science and Plant Nutrition*, 5 (1959): 89.
[48] NRS Weekly Summary No. 13, 12 January 1946, 4, Civil Affairs Section (hereafter CAS) Records, file 4, box 2296, Record Group (RG) 331, US National Archives II (hereafter NAII).
[49] Swanson, 'Fertilizers and food production in Japan', p. 7.

reconnaissance soil survey was started because modern soil maps of Japan were not available which could be used as an aid in maximizing food production'.[50]

Fourteen American soils or agricultural specialists worked on the project, and set about classifying soils according to the soil profile as was now established practice.[51] They served

Order	**Broad Generalized Separation**	**Great Soil Group**	**Area (hectares)**	**Percentage of total area**
Zonal	Podzolic soils	Gray-Brown	1,704,631	4.63
		Yellow	827,504	2.36
		Red	101,480	0.28
		Total Podzolic	2,678,615	7.27
	Total zonal soil		2,678,615	7.27
Intrazonal	Bog soils	Bog soils	192,551	0.52
		Half bog soils	30,615	0.08
		Total	223,166	0.6
	Planosols	Planosols	430,054	1.17
	Ando soils	Ando soils	3,099,607	8.42
	Total intrazonal		3,752,827	10.1

[50] Swanson, 'Reconnaissance Soil Survey of Japan', Reprinted from *Soil Science Society of America Proceedings*, vol. II, 1946, NRS Records, file 5, box 9046, RG331, NAII.
[51] Those involved were soils or agricultural specialists, who worked for the US government.

Azonal	Lithosols Alluvial soils Total azonal	Lithosols Alluvial soils	24,995,786 5,195,900 30,191,686	67.81 14.09 81.90
Water			231,800	0.63
TOTAL			36,858,508	100

Table 1, Area of Great Soil Groups [52]

from a few months to several years and worked closely with Japanese scientists and technicians to distinguish between soil types, groups and associations. Reflecting pedology's emphasis on the climatic processes of soil formation, zonal soils with mature soil profiles in line with a particular regional climate were differentiated from less well-defined intrazonal ones and azonal soils with distinctive profiles that reflected particular local conditions and geological substratum.[53]

Within these categories, the American soil scientists identified ten of the internationally recognized thirty-seven 'Great Soil Groups', the most important of which were gray-brown, yellow and red podzolic soils (from the Russian words *pod* meaning soil and *zol* ash), brown and black ando soils (from the Japanese words *an* meaning dark and *do* earth or soil), lithosols and alluvial soils. The podzolic soils made up 7.27% of Japan's land area, ando soils 8.42%, thin, stony lithosols on mountain slopes 67.81% and alluvial soils on fertile lowlands 14.09%. Table 1 summarizes this information and includes other soil groups that are not discussed due

[52] Adapted from NRS Report 110-1, *Reconnaissance Soil Survey*, p. 25.
[53] Hillel, *Out of the Earth*, p. 23.

to the very small percentages of land they covered. The dominant mountainous topography of Japan, demonstrated by the great preponderance of lithosols, severely restricts the reach of agriculture, as does the terrain of much of the remaining third. Only around 16% of the soil area was cultivable.

The RSS further subdivided the great soil groups into soil associations, which noted differences in texture, colour, slope, the degree of erosion and in the case of alluvial soils drainage, all of which would have a bearing on soil composition, the crops best suited to particular conditions and associated fertilizer requirements. The summary report of the survey lists 125 soil associations across the ten soil groups identified in Japan. It divided gray-brown podzolic soils, for example, into soils on uplands and those on high terraces. Within the former category there were associations based on texture (course or medium) and topography (hilly or rolling) and in the latter more associations along these lines – sandy and fine textured in addition to coarse and medium, undulating with regard to relief, and ones concerned with colour (light and dark).

Each association was given a 'location', indicating the respective RSS area in which it occurred [54] – for example, high terraces with 'gray-brown podzolic soils, coarse textured, light coloured, undulating', were found in Northern Honshu. Whilst this area and Hokkaido were characterized by gray-brown podzols, the red and yellow variants were dominant in the southern third of the country. In terms of their agricultural utility, these soils of varying texture were used mainly for non-irrigated upland crops, but in some locations, especially in the south of Japan, they were bench-terraced and devoted to irrigated rice. Commenting on

[54] The soil scientists divided Japan into eight areas for survey and mapping purposes: Kanto Plain, Kyushu, Kyoto, Shikoku, Hiroshima, Nagoya, Northern Honshu and Hokkaido.

their productiveness, one American specialist noted that the podzolic soils were 'low in inherent fertility' but 'respond[ed] readily to application of fertilizer and lime'.[55] The latter was necessary to correct the soil's high acidity.

Interestingly Ando soils (or *andosols*) were approved as a new great soil group in early 1947, following representations by the Occupation's NRS to the US Department of Agriculture. It was stated that this group, including soils previously classified as Brown Forest, Prairie-like Brown Forest and Black, covered about half the intermediate slopes of Japan.[56] The RSS described these soils as well-drained, dark coloured and derived largely from wind-deposited volcanic ash, and divided them into brown and black soils. The main difference was the higher content of organic matter, darker colour and less defined subsoil development of Black Ando soils. *Andosols* were prone to erosion by water on rolling to hilly slopes and wind erosion affected broad cultivated areas when the surface was dry in winter months. Most of these soils were cultivated as dry fields but irrigated rice could be grown if there was enough water. The main crops planted in these soils were wheat, barley, sweet potatoes, mulberry, vegetables, tea and some fruit. As regards fertilizer requirements, superphosphate or its organic equivalent was necessitated by a deficit of phosphorus. Ando soils were found throughout Japan and were second only to alluvial soils in their agricultural importance.[57]

This was underlined by one of the American soil scientists, Carl Swanson, who summarized the RSS's findings in *Science* towards the end of 1947. He explained that the alluvial soils of the lowlands fed the majority of Japanese, supporting paddy or irrigated rice during the

[55] M. Y. Nuttonson, *Ecological Crop Geography and Field Practices of Japan* (Washingon DC: American Institute of Crop Ecology, 1951).
[56] *Summation*, No. 18, March 1947, pp. 69-70.
[57] NRS Report 110-1, *Reconnaissance Soil Survey*, pp. 29-31.

summer, together with wheat or barley in southern Japan during the winter. Swanson captured the pressing nature of Japan's food problem in just a couple of sentences: 'For maximum crop yields, most of the soils of Japan require heavy fertilization and liming. Fertilizers are of real importance because of the intensive agriculture and because the scarcity of agricultural land makes it important to secure high yields from every crop grown'.[58]

Producing more chemical fertilizers

The stress placed on producing more chemical fertilizers to enhance the fertility of its soils caused policies around Japan's agricultural productivity to become indissolubly linked with the speed of its industrial recovery. It was thus not surprising that the 'fertilizer problem' involved many more sections of the Occupation than just the NRS. Indeed, such was the priority given to confronting this challenge by GHQ SCAP that a special Fertilizer Advisory Committee was established on 28 March 1946, which met regularly thereafter. This reflected the conviction that only by working closely together could interested parties in GHQ and responsible members of the Japanese government effectively coordinate the necessary industrial processes and, following the manufacture of chemical fertilizers, their effective distribution throughout the country. The head of NRS, Hubert Schenck, chaired the committee's weekly meetings, usually attended by representatives of many sections of GHQ SCAP: members of the Economic and Scientific Section or ESS (from its industry, import-export and price control and rationing divisions); Government Section (Korea division); Public Health and Welfare Section (preventative medicine division); US Armed Forces Pacific (AFPAC) G-4 (transport and logistics); and of course NRS (from agriculture and mining divisions). They were joined by several members of the Japanese government, namely

[58] Swanson, 'Reconnaissance soil survey work in Japan', *Science*, 106 (1947): 258.

the Minister of Agriculture and Forestry and the Minister of Commerce and Industry, both accompanied by officials with relevant expertise.[59]

The size of the meetings captures the scale of the problem. Some of the attendees merit explanation. Government Section, the most well-known engine of reform and instrumental in drawing up the new constitution, sent a representative from its Korea division to ensure that the fertilizer needs of the US occupation zone there were properly acknowledged alongside those of Japan. The industry division of ESS was tasked with assisting the Japanese government to tackle the numerous obstacles inhibiting factory production, namely the repair or conversion of industrial plant and the dearth of coal and such key raw materials as phosphate rock. This is where the import-export division came in, working out how best to secure supplies of these and (by means of exports) to pay for them. The presence of officials from the price and rationing division reflected the need to set prices at a level affordable to farmers but not so low as to discourage those producing and selling the products. US AFPAC G-4 was involved, because it quickly became clear that the military would need to provide transport to supplement Japan's meager capacity. Japanese representation mirrored the concerns of the Occupation with production, transport, allocation and distribution. The diverse membership of the Fertilizer Advisory Committee highlighted the complexity of the problem they were all struggling to resolve.

Members of the preventative health division of the Public Health and Welfare Section directed their attention to the proper treatment of night soil as a source of organic fertilizer. Established practice was to compost it over several months to eliminate pathogens, but such safeguards

[59] NRS Weekly Summary No. 25, 6 April 1946, CAS Records, file 4, box 2296, RG331, NAII.

had broken down amidst the chaotic conditions that attended Japan's defeat, causing its premature application as fertilizer in the absence of chemical substitutes. Those concerned with preventative health were also exercised by pervasive evidence of malnutrition, best corrected by increasing production of food crops but more fundamentally by replenishing the soil to correct perceived dietary deficiencies. Francis Jornlin, a scientific consultant with NRS, highlighted these issues at a press conference on 12 November 1947. He explained that 'Nutrition begins with the soil and its value is determined by the food derived from the soil'. Deficits of particular elements in the soil affected the nutritive value of plants, and this continued up the food chain. 'Symptoms of these deficiencies in plants and animals', Jornlin maintained, 'represent danger signals indicating exhaustion of the resources of the soil'. He highlighted the importance of calcium (lime) for human health and contended that the very low average calcium content of Japan's soils explained the high incidence of calcium deficiency amongst Japanese children. To underline his point, Jornlin compared Japan's volcanic soils with those of England and France, where the calcium content was six times greater, and the US and Germany where it was twice as high. He also drew attention to phosphorus, a mineral whose presence in the human body was surpassed only by calcium, and likewise argued that the low levels of phosphorus in Japan's soils translated into nutritional deficiencies in the Japanese diet and attendant health problems. Finally, Jornlin concluded that the 'vital importance of greatly increasing the present home production of fertilizers…and securing adequate imports of commercial fertilizers cannot be overemphasized'.[60]

This was the essential purpose of the Fertilizer Advisory Committee. It quickly set about estimating what Japan could manufacture itself in terms of chemical fertilizers and how best

[60] Press conference, 12 November 1947, Importance of fertilizer and lime to human nutrition and health in Japan', NRS Records, file 2, box 8851.

to make up the deficit, which was a serious one during much of the Occupation. The situation at the end of the war was dire. Whereas consumption of the most important nitrogenous fertilizer, ammonium sulfate, averaged 1,143,000 metric tons annually from 1937 to 1940, it had dropped to less than 300,000 in 1945. This steep fall was explained by damage to factories caused by bombing raids and a dearth of the requisite raw materials, most notably coal, coke and sulfuric acid. As regards the other major inorganic fertilizer, superphosphate, annual consumption was less than 50,000 metric tons, compared with an average of around 1,169,000 during the period 1937 to 1940. In this case, the associated factories, largely unscathed, chiefly suffered from a shortage of phosphate rock, supplies of which barely existed in mainland Japan and so had to be imported.[61] No one had any doubts about the impact of these chemical fertilizers on food supplies. Indeed, the head of NRS referred to them in April 1948 as 'the major factor influencing agricultural production'.[62] Studies by the Japanese Ministry of Agriculture and Forestry showed a 43% increase in rice harvests when ammonium sulfate was added to the soil. Wheat and barley yields doubled and potato harvests increased by 45%.[63]

As nitrogenous fertilizers were applied in higher volumes than phosphorus and much greater ones than potash, NRS prioritized them during the opening months of the Occupation. Those tasked with increasing production faced immense challenges. For example, a group of Americans from NRS's Agriculture Division and officials from the Fertilizer Section of the Ministry of Agriculture and Forestry inspected the Shôwa Denkô Factory at Kawasaki, Kanagawa prefecture, in February 1946. They reported that about three quarters of the plant

[61] *Summation*, No. 1, Sept-Oct 1945, p. 45.
[62] Check Sheet, subject: distribution of fertilizers to farmers, dated 16 April 1948; from NRS to ESS, Economic and Scientific Section (ESS) Records, file 6, box 7585.
[63] *Summation*, No. 1, Sept-Oct 1945, p. 45.

had been damaged by bombing, and that it was producing about 65 metric tons of ammonium sulfate per day, amounting to about 10% of its former capacity. They also visited the factory of Nitto Chemical Industrial Company, Yokohama, which had not been bombed but was hamstrung by urgent repairs, reducing its productivity by half, and insufficient transport for the delivery of such essential raw materials as coal, coke and pyrite (used in making sulfuric acid). Indeed, the company's management blamed this supply problem on the US Eighth Army, accused of monopolizing railway facilities essential for this purpose.[64] In April 1946 members of the Agriculture Division paid another visit to the Shôwa Denkô fertilizer factory in Kawasaki, presumably to check on progress. It was reported that 'the plant is making progress toward repairing bomb damage', but earlier estimates by company officials that daily production of ammonium sulfate would increase to 130 metric tons by 15 April proved over-optimistic. Production by 10 April had barely improved on that of February, reaching just 70 metric tons per day.[65]

The establishment of the Fertilizer Advisory Committee and the Fertilizer Directive (SCAPIN 962) that followed on 17 May 1946 both served to underline the importance of resolving such problems. The directive instructed the Japanese Government to 'place first priority on the production and distribution of fertilizers' and to ensure that essential raw materials, particularly coal, together with necessary equipment, machinery and tools, were reserved for these industries. It called for fair and equitable prices for both the producer and consumer, and authorized sufficient factory capacity for the manufacture of the required amounts of nitrogenous and phosphatic fertilizers.[66] The directive approved the conversion of three

[64] NRS Weekly Summary No. 20, 2 March 1946, CAS, file 6, box 2296.
[65] NRS Weekly Summary No. 26, 13 April 1946, file 7, box 2296.
[66] *Ibid.*, No. 32, 25 May 1946, CAS, file 8, box 2296.

factories from methanol to ammonium sulfate production, bringing the total of such plants to eighteen. Moreover, it identified seven factories that could be converted to the manufacture of calcium cyanamide in addition to the eight existing ones that were now authorized to operate. Such conversions and rapid expansion of capacity underlined the priority being attached to increasing production of nitrogenous fertilizers. Although these measures contradicted the conclusions of the Pauley Mission of December 1945, which targeted all the fertilizer plants for reparations, they were later struck from the list following urgent representations from the Soils and Fertilizer Branch of NRS.[67]

Despite these efforts the production of ammonium sulfate and calcium cyanamide continued to fall short of Japanese requirements by a long way. The quantity of the former manufactured in June 1946 (43,051 metric tons) represented just 35% of farmers' minimum monthly requirements. Any progress was fitful, often interrupted by failure to deliver allocated coal and coke, problems with repair and replacement of equipment, its poor maintenance and delays in transfer of scarce machinery from inoperable factories.[68] Calcium cyanamide was made from calcium carbide, produced by mixing burnt lime with coke at very high temperature (2,000 degrees centigrade). This process involved using electric arc furnaces and was often hampered by breaks in supply that were seasonal due to Japan's dependence on hydroelectric power.[69] For example, at the end of 1946 it was reported that all but one of the plants 'authorized to convert to cyanamide production will be producing in December, but only a small increase is expected in total production because of the severe restrictions on electric power use'.[70] Such problems continued into early 1947 when the production of

[67] Swanson, 'Fertilizers and food production', *Fertilizer Review*, pp. 6-7.
[68] *Summation*, No. 10, July 1946, p. 96.
[69] Mark Metzler, 'Japan's postwar metabolic crisis', pp. 36-37.
[70] *Summation*, No. 15, Dec 1946, p. 91.

calcium cyanamide declined due to insufficient electric power and high-grade coal and coke.[71] In January 1947 a monthly summary of Occupation activities stated that inadequate coal allocations to the fertilizer industry dictated that only 70% of manufacturing capacity could operate. Indeed, the production of three fertilizer plants was either cut back or halted to ensure that the more efficient factories reached their full potential.[72]

All these shortages and chokepoints combined to produce a serious deficit of nitrogenous chemical fertilizers in 1946. In June of that year NRS estimated Japan's farmers would need a minimum of 380,000 metric tons of such fertilizers (on a nitrogen content basis) or 1,900,000 metric tons of ammonium sulfate equivalents (20% nitrogen) for the period 1 July 1946 to 30 June 1947 (1947 fiscal year). Further calculations suggested that Japanese factories could be expected to produce 195,000-260,000 themselves, leaving a deficit, to be covered by imports, of between 120,000 and 185,000 metric tons.[73] NRS transmitted these estimates to Washington DC as part of a case to increase fertilizer imports rather than food.

The American soil scientist, Carl Swanson, a key figure in the SFB, maintained that 'it would be much cheaper and require less labor and ship tonnage space to import fertilizers for crop growing purposes than to import foodstuffs which these fertilizers could produce'.[74] Given that supplies of nitrogenous fertilizers were little more than 340,000 metric tons (68,000 of nitrogen content) from 1 July 1945 to 30 June 1946, the argument for rapidly increasing domestic production and supplementing it with imports was compelling. Colonel Harrison's

[71] *Summation*, No. 17, Feb 1947, p. 97.
[72] *Summation*, No. 16, Jan 1947, p. 95.
[73] NRS Weekly Summary No. 25, 6 April 1946, CAS, file 7; NRS Weekly Summary No. 33, 1 June 1946, file 9, box 2296.
[74] Swanson, 'Fertilizers and food production', p. 3.

Food and Fertilizer Mission of February 1947 estimated that Japanese requirements for commercial plant feeds in the form of nitrogen amounted to 381,000 metric tons for the 1947 fiscal year and 391,000 for the 1948 one. These he insisted were realistic appraisals of Japan's minimum needs and so he recommended imports of 104,000 metric tons of nitrogen in 1947-48, a figure not much in excess of the one actually achieved (96,393). Such were the pressures on supply that Japan was expected to export any ammonium sulfate it could spare to the US occupation zone of South Korea, given that the bulk of production capacity for chemical fertilizers was in the north.[75] An internal memo of September 1947 stated that 'Washington…[wished] Japan to supply Korea…with such ammonium sulfate above Japanese requirements for rice. Amounts of ammonium sulfate supplied should be replaced with ammonium nitrate from the United States'.[76]

However, it was not until well into the second half of the 1947 fiscal year that pressures on the global fertilizer supply were relaxed sufficiently to enable the US to export to Japan ammonium nitrate, produced by government-owned ordnance plants. The first installment amounted to 8,545 metric tons of nitrogen, delivered in March 1947, and by the end of June Japan had received 23,710. By the end of the 1948 fiscal year (30 June 1948) the US had shipped 481,965 metric tons of ammonium nitrate to Japan (96,393 of nitrogen content). These imports supplemented domestic production of 811,914 metric tons of nitrogenous fertilizers (162,383 of nitrogen content) and 993,428 (198,686) for the 1947 and 1948 fiscal years respectively.[77] Given that these figures and those for imports were below the estimates

[75] NRS Weekly Summary No. 25, 6 April 1946, file 7, box 2296.
[76] NRS to ESS, Ammonium sulfate shipments from Japan to Korea during 1948 fiscal year, 18 Sept 1947, file 2, box 8992.
[77] Mark B, Williamson, NRS Report No. 148, *Agricultural Programs in Japan, 1945-51*, Tokyo, 1951, pp. 42-44; *Summation*, No. 20, May 1947, p. 174.

made by NRS in June 1946, particularly for the 1947 fiscal year, it can be assumed that Japanese farmers continued to rely on farm manures for the provision of much of their fertilizer needs as regards nitrogen. The situation was further complicated by the import of ammonium nitrate rather than ammonium sulfate. According to the Japanese Ministry of Agriculture, the use of nitrogen in the nitrate form for basic application to rice was only about 70% as efficient as the nitrogen in ammonium sulfate.[78] Nevertheless, in November 1948, Japanese officials petitioned the head of the ESS, William Marquat, for increased imports of ammonium nitrate from the US. Citing worldwide shortages, Marquat declined to accede to their request, insisting that the Japanese must focus their energies on maximizing indigenous production in order to meet their needs.[79]

Anger over Angaur

The US was more agreeable to increasing imports of phosphate rock, which was treated with sulfuric acid to produce superphosphate fertilizer. The main problem facing the Occupation was how best to access supplies of this raw material, given that Japan had very few stocks of its own. According to an early NRS report on sources of phosphate for Japan, the mines on Kitadaitô Island to the east of the Ryukyu chain (Okinawa) would be able to produce at least 50,000 metric tons of rock annually once the facilities were brought back to a proper state of repair. Looking further afield the report also identified Angaur Island as a key source of supply. Located at the southern end of the Palau archipelago and part of Japan's South Pacific Mandate, granted by the League of Nations after World War One, Angaur boasted high-grade

[78] NRS to ESS, Ammonium sulfate shipments from Japan to Korea during 1948 fiscal year, 18 Sept 1947, NRS Records, file 2, box 8992.
[79] Informal memo to Mr Hideo Suto, Minister of Agriculture and Forestry, and Mr Sanroku Izumiyama, Director General, Economic Stabilization Board, dated 30 November 1948; subject: Nitrogen Availability FY 49 for Japan, NRS, file 2, box 8779.

rock, averaging 38% phosphorus pentoxide. The island's importance for Japan's fertilizer industry had increased towards the end of the 1930s as supplies of rock from North Africa and Florida, together accounting for around half of Japan's imports, dwindled. As was the case with Kitadaitô, the NRS report cautioned that there would be a delay before mining of rock could resume – indeed, the installations and machinery on Angaur would take months to repair or replace following damage incurred during the war.[80]

The Agriculture Division of NRS identified the import of phosphate rock as a major priority, noting that the steep drop in superphosphate production since 1940 has 'brought about a serious decline in the fertility of Japan's soils'.[81] In March 1946 John Rodgers, a scientific consultant for the mining and geology division, made the case for urgent imports, arguing that Japan had sufficient industrial capacity to produce superphosphate, and phosphate rock was less bulky than the equivalent finished fertilizer. In the face of Japan's acute need and a serious shortage of shipping in the Pacific, Rodgers underlined the need to import phosphate rock from points as near to Japan as possible, and so recommended reopening the mines on Kitadaitô and Angaur. He highlighted the latter as 'the first exploited deposit in the former Japanese empire', producing over a million metric tons of rock from 1935 to 1944. Rodgers referred to stockpiles of 45,000 metric tons near the shore, and estimated that the mines could supply up to 100,000 annually once they were in full working order. However, he noted numerous problems with the mining operation at Angaur, and warned that it would take from four to six months to get it running again.[82] In the meantime, Rodgers stated that labour and

[80] NRS Report No. 12, Sources of Phosphate for Japan, 31 December 1945, 1-4, NRS, file 12, box 9015.
[81] *Ibid.*
[82] Memo for record, 25 March 1946, subject: Recommendations for Reopening Phosphate Mines on Angaur, NRS, file 1, box 8992.

lighters were needed for loading stockpiled ore onto ships, and that the US Marianas command at Guam had agreed to assist in supplying them. In April 1946, he concluded with regard to Kitadaitô that despite the ore not being of a high quality, 'resumption of phosphate production on the island would help alleviate Japan's critical fertilizer shortage'.[83]

There were supplies of phosphate on other Pacific islands – Nauru, Ocean, and Christmas Islands – but these were British possessions with their production largely reserved for Australia and New Zealand.[84] The NRS weekly summary for 5-11 May 1946 optimistically referred to 'diplomatic arrangements' that might free up some rock from these islands for Japan.[85] In fact, there was little sympathy for Japan's needs amongst the US's allies, and Angaur itself caused diplomatic tensions between the US and Australia. In May 1947 Canberra formally objected to 'a reported decision by the Supreme Commander to transfer responsibility for the management of the Angaur Phosphate Industry to the Japanese government under his control', and expressed alarm 'over the presence of Japanese laborers in an area close to Australian Fisheries'.[86] The following year, in March 1948, the issue became entangled with the controversy around Japanese whaling in the Antarctic. Responding to proposals from the US Navy to discontinue mining operations on Angaur, the head of NRS, Hubert Schenck, alluded to the Occupation's warning about 'the critical food situation in Japan' in response to Australian misgivings. He went on: 'Withdrawal from Angaur at this time may imply a lessening of the food problem, which could be utilized by members of the

[83] Memo for record, 6 May 1946, Subject: Resuming production of phosphate rock on Kita-daito-jima, NRS, file 1, box 8992.
[84] NRS Report No. 12, Sources of Phosphate for Japan, 31 December 1945, 5, NRS, file 12, box 9015.
[85] NRS Weekly Summary No. 30, 11 May 1947, CAS, file 8, box 2296.
[86] Incoming message from WAR to SCAP (POLAD), 8 July 1947, NRS, file 2, box 8992.

Far Eastern Commission to cause embarrassment for the Supreme Commander with respect to the Antarctic Whaling Expedition'.[87]

Despite these internal disagreements and diplomatic wrangles, the priority for the NRS from the start was to secure supplies of phosphate rock for the manufacture of much needed superphosphate fertilizer. Thus, in early 1946 the SFB had requested that the US Navy dispatch a group of mining and shipping specialists to Angaur to assess the likelihood of its supplying the required quantities of rock to Japan. Headed by Mr Chester A. Fulton, a well-known consulting mining engineer, the Phosphate Mission cautioned NRS in June 1946 that the US Navy's commitment to move 200,000 tons of rock to Japan by the end of the year could not be met due to the poor docking facilities at Angaur and the acute shortage of shipping.[88] In August 1946 Vice Admiral Bruns of the US Navy's Bureau of Yards and Docks complained about the costs of the operation. He remarked that the Island Commander at Guam had recommended that after the 200,000 tons had been shipped to Japan, the rest of the phosphate could be used for fertilizing local farms. Disguising their likely irritation, those representing the Occupation explained that the 'island area is small…, fertilizer needs would not be large and that the phosphate requires processing into fertilizer'. The best solution, they maintained, was for Japan to supply Guam's fertilizer needs as partial payment for the phosphate rock.[89]

[87] Memo for Major General W. F. Marquat, subject: Angaur phosphate project, 1 March 1948, NRS, file 3, box 8992. For a detailed analysis of this controversy, see Christopher Aldous, 'The anatomy of Allied Occupation: contesting the resumption of Japanese Antarctic whaling', *Journal of American-East Asian* Relations, vol. 26, no. 4, 2019, pp. 338-367.
[88] Swanson, 'Fertilizers and food production', pp. 6-7.
[89] Memo for record, 28 August 1946, subject: Procurement of phosphate rock form Angaur, NRS, file 1, box 8992.

Such tensions between the Occupation and the US island command continued after 1 July 1947, when SCAP was authorized by the Department of the Army to take control of the phosphate operation on Angaur. In a memo sent to NRS on 30 October, Major Emzy Lynch, the island's former liaison officer for SCAP, remarked that 'the Naval Government is not in sympathy with the [phosphate] project, and is doing everything possible to hinder it'. Lynch identified such resistance as one of 'a great many disadvantages' that also included poor coordination between the three Japanese companies involved, lazy work practices by senior employees, outdated dryers and 'the dislike of the natives for our allowing the Japanese to mine their phosphate'. He cautioned that the 'present status is inviting communism rather than democracy' and recommended that the project be turned over to the natives and that they be properly paid for their labour.[90] Just a few months later, a scientific consultant for NRS's mining and geology division, John Gregg, undertook an inspection trip to the Angaur mining operation and praised the progress made by SCAP's liaison officer, Major John Woestenburg. He had succeeded in easing Japanese-native tensions, tightening up supervision of the labour force and increasing the efficiency of mining, mechanical drying, phosphate storage and ship loading.[91]

Despite these improvements, a conference convened on 2 February 1948 revealed that a staff study was considering the suspension of the Angaur phosphate project in order to reduce its costs to the American taxpayer and to take account of 'the large stock of rock on hand, and due to arrive from the US'.[92] The US supplied 932,377 metric tons of rock during 1947,

[90] Memo to NRS, 30 October 1947, subject: Phosphate Mining and Drying Operations, Angaur Island, NRS, file 2, box 8992.
[91] Memo for record, 15 January 1948, subject: Inspection of Angaur Phosphate Project, NRS, file 3, box 8992.
[92] Memo for record, 3 February 1948, subject: Angaur Phosphate Project, NRS, file 3, box 8992.

compared with 148,153 from Angaur and 7,250 from Kitadaitô.[93] Nevertheless, Schenck was adamant that phosphate mining should continue on Angaur 'on the present basis', because its high-grade rock supplemented that available from the US, at a massive saving to the American taxpayer (about $5.09/ton compared to around $24/ton). He also cautioned that the project's suspension 'would involve substantial loss of capital to the Japanese, as well as possible loss of prestige by SCAP'.[94] In August 1948, the head of NRS appealed to MacArthur's Chief of Staff, complaining that mining area restrictions imposed by the Civil Administrator, Palau District, Trust Territory of the Pacific Islands, 'limit[ed] the life of the Angaur Phosphate Project to about 1 December 1948'. This was in spite of estimated imports of rock for Japan of 110,000 metric tons for fiscal year 1949 and 180,000 for 1950.[95] Arguments about the agricultural self-sufficiency and hydrologic balance of the island were settled in favour of the US Navy despite strong representations from NRS and the SCAP liaison officer at Angaur (now Major E. C. Richardson).[96] At the end of 1949 Schenck reported that mining would cease on 31 December, but drying operations and shipments to Japan would likely continue for some months thereafter.[97]

The tale of the Angaur phosphate enterprise has been narrated at length, because it shows just how much importance was attached by NRS to fertilizing Japan's soils – the least contentious solution in their minds to the food supply crisis. Imports of phosphate rock, however, involved negotiation with the local US naval command and consideration of Pacific islanders

[93] *Summation*, No. 28, January 1948, p. 246.
[94] Memo for Major General W. F. Marquat [head of ESS], 1 March 1948, NRS, file 3, box 8992.
[95] Memo for Chief of Staff, 3 August 1948, NRS, file 3, box 8992.
[96] Memor for record, 1 September 1949, from Robert Grant, Chief of Mining and Geology Division, subject: Sources of Phosphate Rock in Western Pacific Area, NRS, file 5, box 8992.
[97] Memo for record, 5 December 1949, subject: Action for Termination of Angaur Project, NRS, file 5, box 8992.

and such allies as Australia, all of whom were less than sympathetic to SCAP's demands on behalf of Japan. Once the ore reached Japan, however, the responsible Occupation agencies could direct all their energies to facilitating the manufacture of superphosphate and its efficient distribution to Japanese farmers. As was the case with nitrogenous fertilizers, the Occupation faced too many challenges to make much progress with the manufacture of superphosphate for the first year or so. The same kind of shortages and bottlenecks that obstructed the production of ammonium sulfate and calcium cyanamide affected the output of phosphatic fertilizer.

Production levels increased considerably in 1947. Indeed, compared to 1946, output of calcium superphosphate (16% phosphorus pentoxide) more than quadrupled.[98] Still, the Japanese government struggled with a number of problems. In February 1947, the Occupation's monthly summation of its activities reported that transport difficulties had led to stockpiles of 58,000 tons of finished fertilizer at factories and that the urgent need to produce medicines, matches and industrial chemicals had necessitated the diversion of 375 tons of imported phosphate rock for these purposes.[99] Later summations noted that a shortage of sulfuric acid, due to the slow delivery of pyrite to phosphate plants, meant that only 24% of imported rock could be processed. Also identified as a challenge was the lack of drying capacity for Angaur rock with its high moisture content, one solution to which was the mixing of this with low-moisture Florida rock, 'now being imported in ample quantities'.[100] Finally, the principal chokepoint was the supply of sulfuric acid, for which the main competitor was the ammonium sulfate industry.

[98] *Summation*, No. 28, January 1948, p. 110.
[99] *Summation*, No. 17, February 1947, p. 100.
[100] *Summation*, No. 18, March 1947, p. 94.

Prospects and legacies

In a press conference held on 4 May 1949, Ernest Staker of NRS's Agriculture Division was at pains to disavow claims that 'the fertilizer situation in Japan was rosy', stating that it had indeed improved but not to the extent required – the estimated supply for 1949 was still only around 73% of what it had been in the second half of the 1930s. Nevertheless, he confidently predicted that within a few years Japan would be able to produce all the nitrogenous fertilizer she needed and the necessary superphosphate from imported rock. Staker concluded a statement issued to the Japanese press by cautioning them that 'the problem of maximum food production is of major importance in as much as Japan is dependent upon the United States for her deficit needs'. He insisted that it was incumbent upon all Japanese concerned to bring about 'material improvements in Japan's food position…by increasing fertilizer production and by [assuring] the adequate and timely use of the available fertilizer supplies'.[101]

Food and fertilizer were still at the forefront of American minds, but their thinking was now different from what it had been in the crisis years of 1946 and 1947, when the Occupation had been concerned principally with forestalling famine, and the disease and unrest that would follow in its wake. Despite the opposition of many of its Allies to its food policy in these years, such tensions gave way to support for the US against the Soviet Union as the Cold War developed from 1948. This is conventionally associated with a major shift – a so-called 'reverse course' – in US policy in Japan from an emphasis on democratic reforms to one on economic recovery. However, as this article has shown, the Occupation's early concerns with food supply, the fertility of Japan's soils and domestic output of chemical fertilizers,

[101] Press conference on the 'fertilizer situation', 4 May 1949; Press conference statement by Mr E. V. Stalker, Fertilizer Situation, 4 May 1949, NRS, file 1, box 8779.

demonstrate its commitment to economic recovery from the start. Indeed, Theodore Cohen, a key figure in the ESS, remarked that 'without economic recovery, democracy would never last'.[102] He also noted that by 1949 so great were food imports from the US in the form of GARIOA (Government Aid and Relief in Occupied Areas) that 'the Japanese could not eat the food as fast as the United States was shipping it in'.[103] The total of GARIOA assistance from the US would eventually reach $2bn, which was not much less than the scale of the Marshall Plan in Europe. By the mid-1950s, food aid from the US, essentially driven by the need to dispose of large agricultural surpluses, produced counterpart funds that were used to promote Japanese industrial exports to south and south-east Asia. As Michael Barnhart puts it, 'Washington was positively eager to press for Japan's integration into the newly built multilateral economic apparatus of the Free World', and ensured that Japan joined the World Bank, the IMF and GATT shortly after the Occupation concluded in 1952.[104]

Japan's Cold War alliance with the US was also the context for major imports of technology from the US, mainly for the chemical as well as machinery and electrical sectors. This assistance, combined with the strong foundations laid by Japanese companies during the interwar period, led to the phenomenal expansion of Japan's chemical industries during the 1950s and 1960s. Indeed, the infamous case of Minamata disease (mercury poisoning), 'one of the worst environmental disasters of the Twentieth Century', was caused by the Nippon

[102] T. Cohen, *Remaking Japan*, p. 139 (New York: Free Press, 1987).
[103] Ibid, p. 145.
[104] M. Barnhart, 'From hershey bars to motor cars: America's economic policy toward Japan, 1945-76', in A. Iriye and R. Wampler, eds, *Partnership: The United States and Japan*, p. 202 (Tokyo: Kodansha, 2001).

Chisso factory, originally established at Minamata in 1909 by Noguchi Jun, a Japanese pioneer of the manufacture of nitrogenous fertilizers.[105]

Less notorious than the contamination of the sea food in Minamata Bay but problematic for soil health and biodiversity was the intensification of farming practices, fueled by large increases in chemical inputs as fertilizers and pesticides – ironically the latter were necessitated by the need to mitigate the effects of disease caused by mineral fertilizers. Consumption of ammonium sulfate during the period 1950-55 (1,525,242.6 tons) surpassed the prewar peak years of 1936-40 (1,095,904.4) and the figures for superphosphate followed a similar trend, the higher figure occurring just slightly later (1956-60).[106] The use of inorganic fertilizers soon dwarfed that of organic ones, reaching a stable level in the 1970s-1990s.[107] In a 1981 publication on fertilizer use, the Food and Agriculture Organization noted that on average Japanese farmers spread 287.9 kilograms of mineral fertilizers on rice crops during the period 1971-75 compared to just 150.8 for the period 1951-55. The equivalent figures for organic manures were 97 and 48.5 kilograms.[108] While the Occupation, the Cold War partnership between Japan and the US and the rapid economic development it facilitated were major factors in this rebalancing of the fertilizer mix, it is also important to note that the trend began in the 1930s. Writing about night soil in wartime and postwar Japan, Paul Kreitman

[105] T. Morris-Suzuki, *The Technological Transformation of Modern Japan*, p. 114 (Cambridge: Cambridge UP, 1994).
[106] T. Ogura, *Agricultural Development in Modern Japan*, p. 371 (Tokyo: Fuji, 1970).
[107] N. Katayama, Y. Baba, Y. Kusumoto, K. Tanaka, 'A review of postwar changes in rice farming and biodiversity in Japan', *Agricultural Systems* 132 (2015): 78.
[108] 'Crop production levels and fertilizer use', *FAO Fertilizer and Plant Nutrition Bulletin*, pp. 59-60 (Rome, 1981)

notes that the shift to chemical fertilizer might be seen as 'more suited to the techniques of capital-intensive mass production favored by an industrialized society'.[109]

The intensive use of chemicals and new seed varieties able to tolerate them had a damaging effect on the natural environment. Leaching and runoff caused such problems as eutrophication and nitrate pollution of ground water.[110] One Japanese writer contended that whilst 'modernized' agriculture had generated higher harvests in the beginning despite the saving in labour, chemical fertilizers were 'destroying the vital properties of the earth'.[111] As in other developed countries, the 1990s marked a shift in thinking around what Conrad Totman characterizes as 'industrial-age agronomics'.[112] In 1999 the Japanese government passed a law promoting sustainable agriculture, the key principles of which were soil conservation and biodiversity – most strongly represented by organic farming that rejects chemical inputs and its associated soil degradation and trusts in 'the enhancement of ecosystem services'.[113]

Conclusion

[109] 'Attacked by excrement: the political ecology of shit in wartime and postwar Japan', *Environmental History* 23 (2018): 358.
[110] Simon Pedro Izcara Palacios, 'Farmers' attitudes towards sustainable agriculture in Japan', *Japanese Studies*, 25 (2005): 88; Hayami Yujiro, 'Institutional aspects of agricultural development', in Hayami and Yamada (eds.), *The Agricultural Development of Japan*, pp. 61-108 (Tokyo: University of Tokyo Press, 1991).
[111] K. Nozoe, 'At dangerous crossroads – Japan's agriculture and food security', *Japan Quarterly*, 28 (1981): 225.
[112] C. Totman, *A History of Japan*, p. 496 (Oxford: Blackwell, 2000). For an interesting study of 'rural resettlers' committed to organic farming, see John Knight, 'The soil as teacher: natural farming in a mountain village', in Pamela Asquith and Arne Kalland (eds), *Japanese Images of Nature: cultural perspectives*, pp. 236-55 (Richmond: Curzon, 1997).
[113] N. Katayama et al, 'A review of postwar changes': 78.

As John McNeill and Verena Winiwarter put it, 'Soil ecosystems remain firmly, but uncharismatically, at the foundations of human life'.[114] Any account of food and agriculture during Japan's postwar period must consider the health of the soil and the availability of plant nutrients, namely nitrogen, phosphorus and potassium. What was predominantly an agriculture founded on organic inputs up to the 1930s became one by the 1970s based on soil chemotherapy that was highly productive but brought short term gains at the expense of long term prospects. It was this growing realization of the downside of industrialised agriculture that caused many Japanese to turn to organic agriculture in the 1970s. Aoki Ryoichi's translation of Rachel Carson's *Silent Spring* (*Chinmoku no Haru*) appeared in 1974. By this time consumers concerned about the quality and safety of their food, particularly in relation to chemical residues, looked increasingly to the soil for reassurance.

This article has highlighted how the 'fertilizer problem' as represented by the Occupation began as one defined by Japan's food supply problem. The latter was initially the most important challenge facing the US, because it threatened to cause famine, disease and unrest, and so justified imports of food relief that were seen as overly generous by its allies. Less controversial were imports of ammonium nitrate and phosphate rock from the US. The former supplemented inadequate domestic production of calcium cyanamide and ammonium sulfate, the latter was in addition to supplies of ore from Angaur. Its mining caused tensions with the local US naval command and with the Australian government that rejected Japanese involvement on an island uncomfortably close to its own territory and fisheries. Japan's fertilizer deficit thus provoked disputes between different American commands and, more importantly, between the US and a key ally in the region, already exercised over the return of

[114] J. R. McNeill and V. Winiwarter, 'Breaking the sod: humankind, history and soil', *Science*, 304, 11 June 2004: 1627.

Japanese whaling factories to the Antarctic. It is telling that the US chose to increase imports of phosphate ore from Florida, and to discontinue Japanese operations on Angaur. The twin issues of food and fertilizer thus shed light on the international or *Allied* Occupation of Japan, so often overshadowed by the US's dominant position.

Moreover, the 'fertilizer problem' highlights the Occupation's environmental dimension, most notably the pivotal importance of the work of the NRS for its efficacy as a whole. Despite being marginalized in most accounts of this period of Allied control over the Japanese, the NRS confronted the fundamental problem of Japan's dearth of natural resources, most notably its scant supply of arable land and the relative infertility of its soils. It engaged in a comprehensive reconnaissance soil survey, with a view to determining patterns of land use and optimal applications of fertilizer. Thus the NRS was a key agent of food policy in ways that have not been properly acknowledged.

In the early years of the Occupation, the 'fertilizer problem' was seen as the key to safeguarding Japan's future as a democratic, peaceful nation, and the strong emphasis placed on ramping up production of chemical fertilizers in order to maximize food production reflected this conviction. As the Occupation neared its conclusion, however, it was more strongly associated with industrial recovery, particularly with regard to the heavy industrial sector. Japan's embrace of chemicals reflected not only the US's confidence and associated expertise in technological solutions to agricultural problems but also the Japanese government's keenness to build on its 'second industrial revolution' of the 1930s and its determination to make full use of its 'access to advanced US technology' – its reward for its

'acquiescence in the "containment" of communism…'.[115] The Cold War and Japan's close relationship to the US provides the essential backcloth to the double-digit economic growth of the 1960s and the appalling pollution that came in its wake, causing the 'fertilizer problem' to become an explicitly environmental one by the 1990s. As Toshihiro Higuchi observes, 'Today, the nature of the problem has shifted from scarcity to excess, and the overuse of chemical fertilizers has reshaped Japan's ecological landscape'.[116]

[115] John Dower, 'The useful war', *Japan in War and Peace: Essays in History, Culture and Race*, p. p. 14 (London: Fontana, 1996).
[116] T. Higuchi, 'Japan as an organic empire', p. 154.