A Global North-South Mediterranean Exchange 1891-1990: Pastures for Dryland Crop-Livestock Systems[1]

Derek Byerlee,
Independent Scholar,
Coral Gables, FL, USA.

1 April 2023

Acknowledgements. I am grateful to Jock Anderson, Karen Brooks, Scott Christiansen, Helen Ann Curry, Greg Edmeades, Gus Gintzburger, Edith Hesse, Simon Jackson, Nadim Khouri, Tom Nordblom, and members of the South Australian Agricultural History group who provided valuable information and comments for this paper. I owe a big thankyou also to the librarians and/or archivists for providing access to obscure research reports and unpublished documents at the University of Adelaide, Australian National Library, CSIRO, National Archives of Australia, David Lubin Library of FAO, Georgetown University, ICARDA, Miami-Dade Public Library, South Australian Public Library, and the US National Agricultural Library.

[1] Paper originally prepared for a workshop, Livestock as Global and Imperial Commodities: Economics, Ecologies and Knowledge Regimes, Berlin, 14-15 July 2022.

Table of Contents

Abstract

This paper traces the interactions of scientists, farmers, and politicians of the State of South Australia (SA) with countries of the Middle East and North Africa (MENA) in the two-way flow of technology and knowledge for integrating legume pastures in dryland farming systems. These exchanges were motivated by the strong similarities in the climate of the two regions, both characterized by a relatively dry Mediterranean climate. From the 1930s SA farmers and scientists developed productive dryland farming systems through the integration of sheep and wheat. As detailed in Part II the key to this system was the incorporation of legume pasture species that had arrived accidentally in SA from the countries of the Mediterranean region. Part III then describes how SA scientists made sporadic exchanges and visits to the Mediterranean region from the late 19th century to obtain more diverse pasture species and wild types. This culminated in systematic and increasingly frequent, scientific expeditions from the early 1950s to collect wild pasture species, after their huge economic benefits to SA agriculture became apparent. Based on these collections and many subsequent expeditions, SA established the world's largest gene bank for Mediterranean pasture legumes that became an integral part of its scientific efforts to improve its crop-livestock farming systems.

Part IV relates how South Australia attempted to export their dryland farming system including the pasture legumes back to the MENA countries from around 1970. This reverse transfer was initiated through the Food and Agriculture Organization of the United Nations and CGIAR (formerly the Consultative Group on International Agricultural Research). However, much of the transfer was contracted by the South Australian public and private sectors directly with countries and organizations in MENA. The major aim was to establish markets for SA machinery, technical expertise and even pasture seed derived from species endemic to the region using resources provided by the oil boom in the region in the early 1970. At the same time, Australian scientists and some local officials in MENA saw a huge opportunity to improve cereal and livestock productivity that would accelerate development of the region. More than a dozen research-cum-demonstration projects were mounted employing Australian expertise. Some of these were technically successful but ultimately failed due to a host of social, economic, and institutional reasons.

The concluding section reflects on the limitations of using "climatic analogues" as a basis for technology transfer especially across regions of very different social and economic contexts and cultures, the place of international organizations in the post-colonial period in breaking down long standing imperial barriers to scientific interchange, and the outsized role of individuals who enthusiastically championed the application of a specific technology in the face of mounting evidence of its lack of suitability.

A Global North-South Mediterranean Exchange 1890-1990: Pastures for Dryland Crop-Livestock Systems

I. Introduction

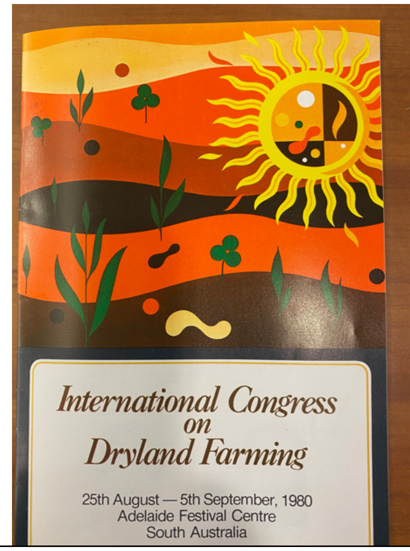
In 1890 Arthur J. Perkins, the manager of a large wheat farm and vineyard in the French Protectorate of Tunisia received a letter from South Australia inviting him to apply for the position of government viticulturalist.[2] South Australia (SA) was a fledgling but largely self-governing colony under the British crown with a population of 325,000 that mainly depended on an export economy of wheat and wool. Although Perkins was a British national, he had grown up in North Africa and studied agricultural science at the L'École Nationale d'Agriculture in Montpellier in the south of France. The lengthy correspondence during his recruitment clearly demonstrated an acute awareness that South Australian agriculture was based on a dry Mediterranean climate and had many parallels to North African agriculture. As Perkins himself noted "it is a pleasure to know that I shall not require acclimatizing".[3] Still there were doubts about his suitability since he was not yet 21 years old. To boost his case, he noted his experience managing a vineyard and that he spoke French and Arabic fluently—but then added "I presume these languages would not be of any use in Australia."[4] In the end, his Montpellier degree and practical, albeit limited, experience in viticulture prevailed and he was offered and accepted the job. Before departing he received another letter on behalf of the SA minister in charge of agriculture requesting that he collect seed to the value of £20 for a wide variety of cereals and forages from the region "grown on the northern and southern shores of the Mediterranean…bearing in mind that the climate [of SA] is similar to the Mediterranean area."[5]

Perkins arrived in SA in 1892 and went on to become a leading personage as professor and then Director of Agriculture until retiring in 1936. It is not known how successful his seed shipment was, but seed of some Mediterranean forages were widely distributed to the farming community soon after he arrived. Periodically, Perkins and others returned to the Mediterranean region to seek forages suited to the diverse conditions of SA agriculture and after World War II (WWII). systematic efforts were mounted by Australian scientists to explore and collect the rich genetic diversity of Mediterranean forages. In the mid-20th century several pasture legumes from the *Trifolium* (the clovers) and *Medicago* genera (notably the annual medics) transformed dryland farming in SA. These all originated in the Mediterranean region although most were introduced accidently from the time of settlement. By the 1950s, these pasture species had become the core element in integrating crop and livestock farming in SA that greatly increased agricultural productivity and enriched soil fertility.[6]

[2] J. Daniels (ed), *The Personal Letterbooks of Professor A.J. Perkins, Government Viticulturalist in South Australia*, 1890-1901 (Roseworthy, S.A.: Roseworthy Agricultural College, 1982). Letter 20 Oct 1890.
[3] *Ibid,* Letter 25 March 1891
[4] *Ibid*. Letter 20th Oct 1890
[5] *Ibid.* Letter 11th April 1892
[6] More detail is provided in Section II and in D.W. Puckridge & R.J. French, "The annual legume pasture in cereal-ley farming systems of southern Australia: A review," *Agriculture, Ecosystems & Environment* 9, 3 (1983): 229-67.

By 1980, SA was sufficiently confident of the success of its dryland farming systems that it hosted a major international congress attended by some 450 delegates with about one-third from overseas and the largest contingent from the Mediterranean region (Figure 1).[7] The congress showcased SA's agricultural achievements and invited the rest of the world to learn from this experience. Delegates were provided an attractive book on *South Australian Farming Systems* with detailed color maps and climatological data to illustrate other areas of the world with a similar Mediterranean climate where these systems could be employed (Figure 2).[8] They also watched a film on SA farming, *Food from the Reluctant Earth,* that, like the book, had been translated into Arabic and French to reach the delegates from Middle East and North Africa (MENA). After the conference, they toured SA dryland farming areas to observe firsthand the farming system based on rotation of a cereal crop with a pasture legume in what was termed "ley farming". Finally, and most importantly, overseas delegates were invited to purchase SA expertise, machinery, sheep breeds, and even seed of the forages originating in their region. MENA was seen as a vast new market for SA products.[9]

Figure 1. This colorful program brochure depicting cereals and pasture legumes. greeted delegates to the dryland farming congress, 1980



Motivated by a mix of commercial, scientific, and humanitarian objectives the SA government and South Australian scientists, farmers and private agro-industries were already engaged in several projects to transfer the dryland farming system to countries in MENA. These were lofty ambitions for a small State still with a population of only about one million and some 6,000 'broadacre" farmers, relative to the estimated 100 million people and about 10 million farmers in similar climatic environments in MENA.[10] Still, the world food crisis of the early 1970s had put a spotlight on spiralling grain and meat imports in the MENA region, while the accompanying oil price spike had provided the resources for many countries of the region to ambitiously invest in their agriculture using SA expertise and technologies.

This paper begins by describing the main institutions and actors that developed the SA dryland system, noting how imperial links with Britain contributed to building SA into a global leader of pasture science using species from the Mediterranean region. It then reviews the efforts by these same institutions and actors to systematically explore the Mediterranean region for wild forage species and strains that could be directly introduced or that could enhance the genetic diversity

[7] *International Congress on Dryland Farming. Proceedings* (Adelaide: Dept of Agriculture, 1984). T. W. Speedie, Report on International Congress on Dryland Farming, Adelaide, SA. District Conservation Office, Swan Hill, Victoria, 1980. File No. SC/D/42.

[8] G. D. Webber, P. G. Cocks & B. C. Jefferies, *Farming Systems of South Australia: Dryland Farming in a Semi-arid Climate* (Adelaide: Dept of Agriculture, 1976).

[9] A. Tideman, *The Medic Fields* (Adelaide: SAGRIC Int., 1994).

[10] J. Dixon, A. Gulliver, & D. Gibbon, *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World* (Rome: FAO, 2002).

for forage breeding programs in SA. The final section describes the 'return of the medic' through as many as a dozen technology transfer projects in MENA from 1970 to 1990 that in the end, largely failed.[11] The conclusions reflect on the processes and limitations of agricultural technology transfer across very different social, economic, and cultural contexts, despite their climatic similarities.

Figure 2. Maps showing the climatic analogues of SA with countries of the Mediterranean region. The light brown represents the dryland cereal system with about 2.5 million ha of wheat and barley in SA (top) and about 18 million ha in the Mediterranean region (bottom), mostly in MENA. Scale is about 1 cm to 400 km for MENA and 1 cm to 200 km for SA.[12]

The analysis of the flows of the pasture legume technology in both directions highlights four major themes in this paper. First there was a sense of excitement about the SA achievements with ley farming and Mediterranean pasture legumes, more generally. The author of a popular history of pasture improvement in southern Australia concluded that "the ley farming system of the 1950s was seen as brilliantly successful" and with its low use of agro-chemicals notably nitrogen fertilizer, it was "a green' system of great natural gain."[13] This was all the more notable, given that other industrialized countries had depended on nitrogen fertilizer that had become much cheaper after WWII, to raise their yields. This was also the model for the Green Revolution that emerged in the irrigated areas of Asia from the mid-1960s. Indeed, the SA success in raising yields was especially striking as it occurred in dryland farming areas that had

[11] The "return of the medic" borrows from S. A. Breth, *Return of the Medic* CIMMYT Today No. 3 (Mexico DF: CIMMYT, 1975).
[12] Extracted from Webber et al., *Farming Systems of South Australia.*
[13] D. F. Smith. *Natural Gain in the Grazing Lands of Southern Australia* (Sydney: University of South Wales Press, 2000).

not yet been reached by the Green Revolution. On the livestock side, the integration of livestock through year-round grazing in SA again contrasted with the intensive livestock industry emerging in most industrialized countries that increasingly depended on feed grains. In short, SA agriculture provided an alternative model for what today would be termed "sustainable" or "regenerative" agriculture that due to its low use of external inputs and integration of cereals, legumes, and livestock grazing, was considered especially appropriate in the developing world.

The second theme relates to the processes of agricultural technology transfer. From the late 19th century, the concept of "climatic analogues" was recognized—that is areas of similar climates, that spanned regions and even continents.[14] The so-called Mediterranean climate defined broadly as areas between 30 and 40 degrees of latitude (north and south of the equator) with a winter growing season and dry hot summers, was one such analogue that spurred a two-way flow of seeds and other technologies between SA (and southern Australia, more generally) and MENA. The idea was that the performance of a given crop and technology could be replicated in a similar agro-climatic environment. But even if technically replicable, difference in social and economic conditions may curtail the transfer of a given technology. These conditions may be diverse ranging from differences in price relations, endowments of land, labor and capital, local food preferences, laws and customs on land tenure, and institutions, more generally. For these reasons, direct transfer of agricultural technologies across countries is less common than "design transfer", that is transfer of concepts and methods along with further research in the recipient country to modify the innovation.[15] The transfer of technology analysed in this paper took place between regions that differed sharply with respect to social and economic context as well as the scientific capacity to adapt and innovate. Moreover, the initial transfer (from MENA to SA) was quite specific in the form of seed of a new species or variety of pasture to replace an existing pasture variety in an established farming system. By contrast, the transfer in the opposite direction aimed to export an entire dryland farming system that involved many elements of genetics, machinery, tillage practices, rotations, and grazing management—greatly adding to the complexity of adaptation and the requirements for local research capacity.[16]

Third, the historical analysis of transfer processes across a century, reveals how the rise of international organizations such as the Food and Agricultural Organization of the United Nations (FAO) and international agricultural research centers of the emerging Consultative Group on International Agricultural Research (CGIAR) greatly facilitated interaction and technology transfer across distant countries and continents in the post-colonial period. Prior to World War II, interaction within colonial Empires was, of course, common, and indeed encouraged, but much more limited across Empires due to imperial trade rivalries and language barriers. Further, the new international organizations explicitly aimed to provide critical technologies, knowledge, and information that could be widely used by many countries in what came to be known as international public goods. The collection, evaluation, and conservation of thousands of accessions of Mediterranean pasture species and strains that were made freely available was a

---

[14] For example, A. Aaronsohn, *Agricultural and Botanical Explorations in Palestine* (Washington DC: USDA, 1910).

[15] V.W. Ruttan & Y. Hayami, "Technology transfer and agricultural development," *Technology and Culture* 14, 2 (1973), 124-5. Ruttan and Hayami also include a third category, the transfer of human and institutional capacity to develop comprehensive local research programs to develop their own technologies.

[16] D. Byerlee. "Opportunities for and problems of transferring Australian farming systems research to developing countries." In *Agricultural Systems Research for Developing Countries.* ed. J. V. Remenyi (Canberra: Australian Centre for International Agricultural Research, 1986).

notable international public good of the Mediterranean exchange. Indeed, it will be argued that interest in Mediterranean pasture legumes was the stimulus for FAO's pioneering efforts in crop genetic resources.

Finally, a relatively unexplored topic in the literature on technology transfer is the role of individual(s) who energetically and single-mindedly champion a specific technology over many years. Although technology adoption may be recorded in specific niches, the "champion" in his/her enthusiasm sees a much wider role at the regional or global level, despite mounting evidence to the contrary.[17] In the history of the return of medic technology and farming system, there were initially many champions, but most became more realistic about its limitations in MENA. Yet, transfer efforts persisted for decades due to politically well-connected individuals from both sides who were forceful leaders and skilled communicators.

Finally, several caveats are needed to set the stage for the remainder of the paper. First, while the focus on one side of the exchange is on the State of South Australia, the Mediterranean "climatic analogue" in Australia includes adjacent areas in the northwest of the State of Victoria and a much larger area in the State of Western Australia where similar ley farming systems developed often in close interaction with SA. Western Australia also engaged extensively in the Mediterranean exchange but receives superficial treatment in this history. Likewise, on the other side of the exchange the focus is on the dryland farming areas of southern and eastern Mediterranean areas—that is much of MENA.[18] Countries of southern Europe also enjoy a Mediterranean climate but generally with a higher rainfall and limited areas of dryland cereal farming that is the subject of this paper.[19] Third, the annual *Medicago* species, the so-called medics, are emphasized, since they dominated ley farming systems of SA and were the almost exclusive target of efforts to transfer the technology to MENA. The clovers, especially *Trifolium subterraneum* commonly known as sub clover, was and is the most important pasture legume in higher rainfall areas of SA and in much of the Western Australian wheat belt since it better suits its acid soils. However, the story is largely the same for both legume genera so it is simpler to emphasize the medics. As a final caveat, the paper emphasizes the human dimensions of technology transfer—that is, the institutions and people—at the risk of simplifying what is a complex technical subject that has been well treated in an extensive scientific literature cited in this paper.

II. Cultivating the Medics

Beginnings—an unsustainable granary

South Australia was the only Australian colony founded by free settlers (rather than transported convicts from Britain) with the explicit objective of creating a middle-class agrarian society

[17] The idea of a technology champion or "brand hero" is discussed in J. Sumberg, D. Keeney, and B. Dempsey, "Public agronomy: Norman Borlaug as 'brand hero' for the Green Revolution," *Journal of Development Studies* 48, 11 (2012): 1587-1600. However, a major difference to the case discussed here is that Borlaug's semi-dwarf wheat varieties were based on solid science and became the most widely grown varieties in the world.

[18] Defined here as occurring in the annual rainfall range of 250-500 mm, with more than two thirds falling during the winter and spring growing season.

[19] Extensive areas on the west coast of the USA and Chile with a Mediterranean climate are not included, although at one time California was a major producer of dryland wheat with many similarities to SA. J. W. Coulter, "A critical situation in two one-crop wheat farming districts in California," *Economic Geography* 5(1929): 87-97.

based on family farmers.[20] It was also a highly planned settlement where land and rural townships were surveyed, and transport infrastructure designed prior to the settlement that started in 1836. Initially, land was provided on short-term leases to large sheep grazing enterprises that developed an export-oriented wool industry. This system was exploitative not only in treading on the rights and livelihoods of indigenous peoples surviving through hunting and gathering, but in rapidly denuding the natural vegetation. Areas thought to be suited to wheat (roughly in the annual rainfall zone 250-500 mm), were progressively opened to closer settlement through sponsored immigration financed by land sales. While there were many ups and downs in the early years, settlement did eventually proceed in an orderly manner with farms and associated towns laid out progressively north from the planned capital city, Adelaide. Initially farm blocks of 80 acres (32 ha) were offered with the requirement for onfarm residence added later to limit land accumulation and promote egalitarian communities. As settlement pushed northward into drier zones in the 1880s, larger farms of 640 acres were offered that were operated by family labour with the aid of pioneering innovations in labour-saving machinery for ploughing and harvesting.

Despite being the driest of the six Australian colonies in the world's driest inhabited continent, by 1894 wheat was grown by about 12,000 farmers on 630,000 ha and SA had become the granary of the Australia colonies and the top export earner of the colony. [21] With plentiful land in the early years, an extractive system of continuous cropping of wheat developed that mined soil nutrients and led to declining yields and serious soil erosion. With exhaustion of soil nutrients many farmers moved from their "wheat sick" lands to repeat the cycle in newly opened areas. The first breakthrough was the discovery by one of SA's first agricultural scientists in the 1880s of a large and very profitable response of wheat to superphosphate fertilizer reflecting the very low phosphorus content of most Australian soils. The adaptive research to develop economic doses and efficient application methods was carried out by farmers themselves, resulting in almost universal adoption of superphosphate on wheat by 1910.[22] A second major innovation at this time was the adoption of new rust-resistant wheat varieties suited to drier areas, above all varieties developed by William J. Farrer in the adjacent colony of New South Wales. Most farmers also abandoned continuous wheat to introduce a year of bare or clean fallow as recommended by scientists to store moisture and control weeds and diseases for the next wheat crop.[23]

Farmer innovation with pasture legumes

The next step in improving wheat farming practices was to integrate sheep through the inclusion of a pasture phase, especially legumes, in the rotation to replace bare fallow. The story of pasture legumes reversed the roles of farmers and scientists in adopting superphosphate, with farmers in the lead in developing the initial system and scientists providing additional but critical

[20] E. Richards, *The Flinders History of South Australia*. Vol 1 (Netley SA: Wakefield Press, 1986). Douglas Pike. *Paradise of Dissent: South Australia 1829-57* (Melbourne: University of Melbourne Press, 1967).
[21] Only 14% of area in SA is in the rainfall zone, 250-500 mm, and a mere 3.3% receives over 500 mm annually. E. D. Carter, E. C. Wolfe, & C. M. Francis. "Problems of maintaining pastures in the cereal-livestock areas of southern Australia." In *Proceedings of the 2nd Australian Agronomy Conference.* Australian Society of Agronomy, p. 68-82, 1982.
[22] Derek Byerlee, "The super state: the political economy of phosphate fertilizer use in South Australia, 1880–1940" *Jahrbuch für Wirtschaftsgeschichte/Economic History Yearbook* 62, 1 (2021): 99-128.
[23] Later, bare fallow was recognized as accelerating nitrification of organic matter to provide a small amount of nitrogen for the following crop.

refinements, after a considerable delay. Southern Australia had only a handful of native annual legumes and these were unsuited to livestock feed—in fact, many were poisonous. Yet soon after settlement some 35 species of pasture legumes were already naturalized including sub clover (*Trifolium subterraneum)* and several annual medics (*Medicago* species)[24] Most of these had been introduced unintentionally from the Mediterranean region through shipments of animals, animal feed, packing materials and other means.[25] They had been "naturalized" in the sense that they were able to reproduce and spread voluntarily and, in fact, were widely regarded as weeds.[26] Indeed, the pioneering environmental historian, Alfred Crosby in his book, *Ecological Imperialism,* specifically highlighted the extensive spread of Mediterranean "weeds" to dominate the vegetation in European settlements in many parts of the Americas and Oceania.[27] These weeds were especially well adapted to the grazing animals, rotations, and cultivation methods imported by the settlers.[28]

The story of how a SA farmer-seedsman Amos W. Howard identified the potential of sub clover in 1896 and actively championed its wider use is well known.[29] Howard also developed methods to harvest the seed and recognized its excellent response to the application of superphosphate. By the 1920s, other seedsmen had entered the market and sub clover was being popularized throughout the higher rainfall areas. In 1930, the Commonwealth (i.e., federal government) of Australia introduced a subsidy on superphosphate specific to pastures to encourage more rapid adoption. This concept of seeding and fertilizing pastures was a milestone in the development of the livestock industry in the better rainfall areas of Australia.[30] In 1963, Professor Colin M. Donald (more below) recognized the enormous contribution of Howard by establishing a trust fund in his name to support research, study and travel related to pasture science. In the inaugural ceremony in Adelaide, Donald noted that the "sub and super revolution" as it came to be known had been adopted on 25 million hectares and enthused that "there is perhaps no other example in the world of so dramatic an improvement in fertility and production over a vast region."[31]

The "sub and super revolution" benefited higher rainfall grazing areas but did spill over into some wheat growing areas. However, sub clover was not well suited to the extensive areas of dryland wheat with frequent drought stress mostly with alkaline soils that made up over 75 percent of SA's wheat belt. In these areas, annual medics were very well suited and with careful

---

[24] P. M. Kloot, "Plant introduction to South Australia prior to 1840," *J. of the Adelaide Botanic Gardens* 7, 3 (1985); 217-30.

[25] P. S Cocks, M. J. Mathison, and E. J. Crawford, "From wild plants to pasture cultivars: annual medics and subterranean clover in southern Australia," *Advances in Legume Science,* eds. R. J. Summerfield & A. H. Bunting (Kew: Royal Botanic Gardens, 1980), p. 569-596.

[26] Given that most ships stopped in Cape Town, South Africa, that also has a Mediterranean climate, many forage legumes arrived indirectly via South Africa where they were naturalized after settlement there in the 17th century.

[27] A. W. Crosby, *Ecological Imperialism: the Biological Expansion of Europe, 900-1900* (New York: Cambridge University Press, 1986), pp 145-70.

[28] Although many native grasses in SA were suited for stock feed, these were displaced in farming areas by exotic grasses that responded to higher fertility, again mostly originating in the Mediterranean region. The *Rhizobia* bacteria that attach to roots of the legumes had also apparently been naturalized along with their host legumes again arriving in SA via various routes.

[29] Smith, *Natural Gain.*

[30] E. F. Henzell, *Australian Agriculture: Its History and Challenges* (Melbourne: CSIRO Publishing, 2007).

[31] C. M. Donald, "Legacy of the legume: The Howard Memorial Appeal Opening," *J. Aust Inst Agric. Sc*. March 1964, pp. 54.

management could self-regenerate annually from residual seed after the wheat crop.[32] The most common was, *M. polymorpha*, commonly known as burr medic, that was spread throughout the wheat area as a volunteer. However, the burr became entangled with the wool leading to a significant price discount.

The step from naturalization to cultivation of medics in rotation with wheat was a gradual process that took place over half a century. In practice, cultivation of medics ranged from minimally managed volunteer pastures to fertilization and careful grazing of selected or bred strains. By 1908 most farmers were already using a bare fallow-wheat-volunteer pasture rotation, as recognized in an official government brochure at the time.[33] The adoption of superphosphate during this period favoured the strong growth of volunteer medics and the gradual integration of sheep into the dryland wheat farming system.[34] Some farmers had also identified and were experimenting with "burrless" medics.[35] However, no champion such as Howard for sub clover had yet emerged to identify, produce, and market seed of annual medics and to popularize the dryland wheat-ley farming system.

Enter science

There is broad agreement that there was a significant lag in scientific interest in annual medics that were so central to the dryland farming system being developed by SA's farmers. This is surprising given that scientists in the US had been conducting research from around 1900 on at least seven species of annual medics, as well as the associated *Rhizobia* bacteria that attach to legume roots to fix nitrogen. In the south of the USA, they were recommended by the United States Department of Agriculture (USDA) and state experiment stations as a cover crop and green manure to provide nitrogen for the following cotton crop, to prevent soil erosion between crops, and as grazing for "horses and hogs".[36] They also played a similar role in Californian orchards grown in a Mediterranean climate. Since wool production was not an objective in most areas, burr medics were popular including *M. arabica* where winters were colder.[37] USDA also evaluated a wide range of both naturalized and introduced medics in the early 1900s.[38] A seed industry developed, initially based on seed extracted by woolen mills in the UK, often originating in Australia, but over time California became a center for seed production for the whole country. A standard US textbook on forages published in 1925 included a whole chapter on annual medics.[39] As argued below, Australian scientists until WWII were closely linked to

---

32 The most important economic species of the *Medicago* genus is the perennial *M. sativa,* commonly known as lucerne. Lucerne has been widely cultivated from antiquity and was introduced very early into SA as an important sown forage crop. However, as a perennial it was not suited to short rotations in dryland farming systems.

33 Dept of Agriculture, *Notes on Agriculture in South Australia* (Adelaide: Government Printers, 1908).

34 Indeed, about half the sheep in SA were already in the wheat belt by 1935. H. C. Trumble, "The relation of pasture development to environmental factors in South Australia," *J. Agric, SA* July 1935, pp. 1460-87.

35 *Chronicle* 8 March 1902. Technically all medics have some type of burr but the "burrless" type lacks hooked spines that allow them to easily attach to sheep's wool.

36 See for example, A. G. Way, "The grass problem: Agrostology, agriculture, and environmental transformation in the New South," *Environmental History* 28,1 (2023): 60-84.

37 Medics were grown for sheep production in northern California but probably for lamb production rather than wool.

38 R. Mackee & P. L Ricker. *Nonperennial Medicagos, the Agronomic Value and Botanical Relationship of the Species* (Washington: Government printing Office, 1913).

39 J. F. Dugger, *Southern Forage Crops* (New York: MacMillan, 1925).

Britain and there is no evidence (such as scientific citation) that they were aware of these extensive research efforts in the US.

As in the USA, research, albeit delayed, was critical to the full development of the ley farming system in SA in order to identify and develop species, strains, and associated *Rhizobia*, fertilization practices suited to specific rainfall and soil conditions, and appropriate rotations and grazing management regimes. Four institutions involving a handful of scientists played an outsized role within the wider Australian context in pasture research prior to WWII. These same institutions and many of these same actors would lead the Mediterranean exchange on medics after WWII.

The establishment of Roseworthy Agricultural College (hereafter Roseworthy) was the first effort to place SA agriculture on scientific lines and indeed was the first such institution in Australia. Founded in 1883 it emphasized teaching mainly for diploma level courses for agricultural extension workers but also played an important role in applied research. Identification of the strong response of wheat to superphosphate was one of its first and most enduring scientific breakthroughs. When Perkins, the viticulturalist recruited from Tunisia, described in the introduction to this paper, took over as principal in 1904, he actively championed a stronger role for Roseworthy in research.[40] His first priority was to establish a wheat breeding program that became a major source of varieties grown in the state and sometimes interstate and overseas. Roseworthy also conducted valuable work on crop rotations but was slow to recognize the role of sown pasture legumes as a replacement for bare fallowing.[41]

Roseworthy was closely linked to the SA Department of Agriculture (hereafter SADA) when it was established a few years later since most of the staff of SADA were Roseworthy graduates and both institutions reported to the colonial and then State Minister of Agriculture.[42] SADA's primary role was agricultural extension—it started several experimental farms in the early 1900s but it had few resources and trained scientists until after WWII. Reflecting the fluidity of staff between the two institutions, Perkins from Roseworthy was appointed director of SADA in 1914 a position he would hold until 1936.[43] He became an outspoken promoter of bare fallow in a wheat-fallow system and disparaged "weedy fallows".[44] However, after the value of medics was firmly established in the 1950s, SADA would become a world leader in their collection, conservation, evaluation, and breeding.

The leading agricultural research institution in the state became the Waite Agricultural Research Institute founded in 1924 by the University of Adelaide with a donation from a wealthy pastoralist. The foundation professor and first director was A. M. V. Richardson. a graduate of Roseworthy who completed a doctorate at the University of Melbourne. Richardson provided outstanding leadership in the early years including fund raising from both public and private

---

[40] J. Daniels. *A Century of Service: Roseworthy Agricultural College*. (Roseworthy, S. A.: The College, 1983).
[41] *Ibid.*
[42] Another important agricultural institution was the Central Agricultural Bureau that promoted farmer-to-farmer learning, innovation, and information exchange through hundreds of branches throughout the state. The Bureau was linked to SADA but operated independently in its early years.
[43] Under his tenure a long-term rotation trial was established in the high rainfall zone in 1919 that convincingly demonstrated the high returns to using phosphate on sub clover.
[44] L. Chatterton & B. Chatterton, *Sustainable Dryland Farming: Combining Farmer Innovation and Medic Pasture in a Mediterranean Climate* (Cambridge: Cambridge University Press, 1996).

sources.[45] He was supported by a number of junior level staff. One of these was Hugh C. Trumble who would become the leading pasture scientist in the State until 1950. However, before he established his credentials as an agrostologist (as pastures scientists were then known), he was often introduced as "young Trumble, son of the cricketer" since his father, also Hugh, had been an Australian cricket legend around 1900.[46]

In little more than a decade, the Waite had 27 professionals with the best expertise in Australia on pastures, soils and agro-climatology, and its research was recognized internationally.[47] This success reflected its strong imperial links with Britain prior to WWII. Trumble in looking back on his period at the Waite, attributes much of its early success to its partnership with the Welsh Plant Breeding Station at Aberystwyth that was facilitated from 1927 by grants from the Empire Marketing Board.[48] The Welsh Plant Breeding Station under the dynamic leadership of George (later Sir George) Stapledon had become a global center of excellence in pasture science employing a holistic or ecological approach from selection and breeding of new pasture strains, fertilization, and integration of legumes. As well as being a champion of ley farming, Stapledon advocated testing new pasture strains under real world grazing management through extensive onfarm trails with the active participation of farmers.[49]

Stapledon made a nine-month trip to Australia and New Zealand in 1926 reporting his perceptive observations in a book.[50] Years ahead of the still fledgling Australian scientific establishment, he noted the role of volunteer medics in dryland wheat farms and called for the development through breeding of a "burrless medic" adapted to drier regions that would be "a goldmine" to Australian agriculture.[51] He also advocated for an organized effort to cooperate across the Empire in pasture research.

Meanwhile Richardson from the Waite attended the landmark 1927 Imperial Agricultural Research Conference in London, that resolved to build central research institutes for fundamental research and to foster scientific cooperation across the Empire. In the same year, the Empire Marketing Board (EMB) was established with part of its remit to provide research grants that would facilitate cooperation on research that would be "applicable sometimes for the whole Empire, but always to more than one of its countries."[52]

Frank L. McDougall, who would achieve fame after WWII as a founder of FAO, was highly influential in establishing the EMB and in managing its research grants. McDougall had

---

[45] V. A. Edgeloe, *The Waite Agricultural Research Institute: The First Fifty Years 1924-1974* (Glen Osmond, SA: Waite Agricultural Research Institute, 1984). The second founding professor was James A. Prescott, a British specialist in soils who was recruited from Egypt where he had spent six years working on soil fertility in a Mediterranean environment.

[46] For example, W. J. Hudson, and W. Way. *Letters from a "Secret Service Agent": F.L. McDougall to S.M. Bruce, 1924-1929* (Canberra: Australian Govt. Pub. Service, 1986), p. 598.

[47] Edgeloe, *The Waite Agricultural Research Institute*.

[48] H.C. Trumble, "Grassland agronomy in Australia," *Agronomy Review* 4(1950) 1-65.

[49] Stapledon was one of only two of his contemporaries in the agricultural sciences elected a Fellow of the Royal Society. His career is detailed in Robert Waller, *Prophet of the New Age: The Life and Thought of Sir George Stapledon* (London: Faber and Faber, 1962).

[50] R. G. Stapledon, *A Tour in Australia and New Zealand: Grass Land and Other Studies* (London: Oxford University Press, 1928).

[51] *Ibid,* p. 92

[52] Britain funded the EMB largely to reduce pressure by the Empire Dominions for special tariff preferences for trade within the Empire. Roy MacLeod, "Passages in imperial science: from Empire to Commonwealth," *Journal of World History* 4 (1993): 117-150.

emigrated to SA to take up a fruit farm in the newly opened irrigated areas on the River Murray. He was first noticed in a local conference where he and Perkins from SADA provided opposing views on markets for the growing production from the irrigation scheme. Contrary to Perkin's gloomy prognosis, McDougall highlighted the potential in British markets for South Australian dried fruit that Britain was then importing from the Mediterranean areas of Europe. Described by his biographer as having exceptional organizational, networking, and writing skills, McDougall was nominated as a delegate to London for the Australian Dried Fruits Association to negotiate tariff preferences for Australian producers. He soon developed a close working relationship with Australia's prime minister, Stanley Bruce (later Lord Bruce) that greatly expanded the scope of his activities. McDougall became the prime minister's eyes and ears in London as well as a highly effective lobbyist for Australian economic interests in Britain and the Empire, more generally.[53]

McDougall was also a strong supporter of cooperative research across the Empire noting that "fundamental problems are better tackled jointly." He recognized the priority of pasture research having provided an annex to Stapledon's book on Australia on "The economic importance of Empire pastures."[54] He also observed that Aberystwyth was the "intellectual general headquarters" for pasture research in the Empire.[55] Accordingly, one of the first EMB projects linked Aberystwyth, the Waite, and research institutes in New Zealand, Palestine, and South Africa to conduct research on pastures. This project spawned three "agrostologists" who studied under Stapledon and would lead pasture research in the UK, Australia and then internationally for decades. First, "young Trumble" from the Waite spent a year in the UK mostly at Aberystwyth in 1928, greatly enriching his limited experience in pasture research.[56] Second, John (Jack) G. Davies, a graduate of Aberystwyth, was appointed to the Waite in 1928 for nearly a decade and later led research on tropical pastures in northern Australia. Third, his brother, William Davies, was made Imperial Grasslands Investigator at Aberystwyth spending three years in New Zealand and Australia in the early 1930s. Stapledon and W. Davies would author the classic textbook on ley farming as part of the British "plough up" campaign to produce food in WWII.[57]

Through these links, the basic concepts of legume pastures and ley farming were incorporated in Waite research from the beginning. The EMB project focused on mineral nutrition and initiated pathbreaking research that eventually identified widespread deficiencies of "trace elements' in Australian soils.[58] Trumble at the Waite carried out critical research to define variations in crop and pasture growth in relation to climate. It was Trumble too, who from 1939 promoted barrel medic (*M. truncatula*), a "burrless medic" suited to lower rainfall regions. A critical step was the link he built with the private sector to establish a viable seed industry for medics.[59] A later

---

[53] W. Way. *A New Idea Each morning: How Food and Agriculture Came Together in One International Organisation* (Canberra: ANU Press, 2013). Hudson & Way. *Letters from a "Secret Service Agent*.
[54] Way. *A New Idea Each Morning*. p. 82. McDougall was a colleague and friend of W. S Kelly, a leading South Australian farmer who was promoting pasture legumes.
[55] Way. *A New Idea Each Morning,* p. 116.
[56] H. C. Trumble, General account of twelve months abroad, 1928. Manuscript held at University of Adelaide Archives, Series 1268, Item 1.
[57] G. Stapledon & W. Davies. *Ley Farming* (Harmondsworth: Penguin Books, 1941).
[58] D. Byerlee, The role of crop science in opening commodity frontiers. Commodities of Empire Working Paper No. 27, 2017. Accessed online at https://commoditiesofempire.org.uk/publications/working-papers/working-paper-27/.
[59] Barrel medic was earlier highlighted by E. M. Hutton, "The important pasture plants of South Australia considered as to their identification and characteristics," *J. Agric SA* October 1934, 336-346.

review of agricultural achievements in SA concluded that, "Trumble did more than anyone else to identify and promote legumes appropriate to specific environmental factors".[60]

Finally, from the beginning the Waite worked closely with what was later renamed the Commonwealth Scientific and Industrial Research Organization (CSIRO) that was being set up by the federal government at the same time as the Waite. Although CSIRO was to be headquartered in Canberra, many of its staff were located on the Waite campus and Richardson was a member of the three-man Executive Committee of CSIRO. CSIRO as a federal research agency aimed to carry out more "fundamental research" to complement state-level applied research activities. One of CSIRO's early appointees at the Waite was Colin M. Donald, who had arrived from the UK at the age of 16 years to study in Australia. His early work analyzed variability within Australian strains of sub clover and with Trumble, associated the suitability of medics with alkaline soils that dominated the wheat farming areas of the state.[61] Donald took an extended overseas study leave in 1939, again spending much of it at Aberystwyth, and on his return produced a book on Australian pastures in which he argued for plant collection expeditions to support the emerging ley farming system.[62] Donald went on to replace Trumble as professor of agronomy at the Waite in 1954 and to an illustrious career in Australian agricultural science "contributing more than any other person to the understanding of pastures."[63]

Adoption of ley farming

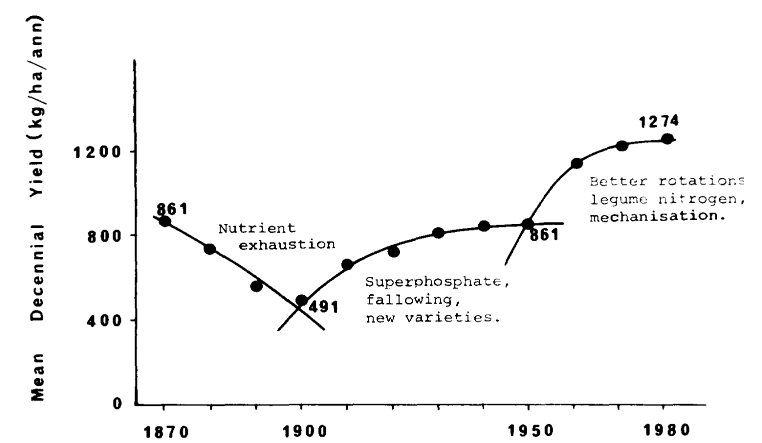
Figure 3: Winter growth of self-regenerating barrel medic after wheat, with sheep in the background, mid-North of SA.

After WWII, changes in farmer circumstances, farmer innovation and an impressive research capacity at state, university, and federal levels, provided the base for widespread uptake of the ley farming system in SA and beyond. With a welcome jump in research budgets in the booming 1950s there was an enormous increase in research on all aspects of the system, including fertilization, the search for new strains, the initiation of breeding programs, and trials on grazing management. Serious droughts accompanied by huge dust storms during the War had also exposed the problems of the bare fallow system. Record wool prices due to the Korean War boom in the early 1950s did more than anything else to stimulate investment by farmers in pasture improvement and enable the build-up of nitrogen and soil organic matter in dryland wheat systems.[64] Australia's trade protectionists policies also ensured a high price of synthetic nitrogenous fertilizer making its use

[60] M. B. Spurling. "Agricultural achievements in South Australia," *J. Aust. Inst. Agric. Sc.* 53 (1987), 61-7.
[61] H. C. Trumble & C. M. Donald, "Soil factors in relation to the distribution of subterranean clover and some alternative legumes," *J. Aust. Inst. Agric. Sci* 4, (1938): 206-8.
[62] C. M. Donald. *Pastures and Pasture Research* (Sydney: Sydney University Press, 1941).
[63] Smith, *Natural Gain*, pp. 86.
[64] With the application of superphosphate, the pasture phase provided sufficient nitrogen for the following cropping cycle. An estimated 7-9 kg N is produced per kg of P applied.

in dryland farming unprofitable or at best a high risk.[65] The private sector also responded through provision of pasture seed, *Rhizobia* inoculants, and improved machinery. Finally, rainfall during the 1950s was well above average throughout the SA wheat belt and this together with high wool prices provided a tail wind to accelerate integration of crop and livestock farming.

Figure 4: A version of the Donald wheat yield curve for Australia, 1860-1980. Each point represents the average yield for the previous decade. Note the yield takeoff in the 1950s due to rotation with legume pastures.[66]



By 2000, medics had been adopted on an estimated 25 million hectares in southern Australia (Figure 3).[67] Adoption was rapid and widespread but by no means complete due to the diversity of agro-climatic and soil conditions and the narrow range of legumes available. From the 1930s to 1970s wheat yields in SA reportedly rose by 50% and wool yields tripled.[68] By 1963, Donald published his famous "opera house" curve of cascading wheat yields that identified a new phase in wheat production beginning in 1950 brought about by adoption of the ley farming system (Figure 4).[69]. The legumes in this system fixed 60-70 kg/ha of nitrogen on average, sufficient to produce a follow-on wheat crop in most years.[70] The benefits to Australia of adopting pasture legumes were estimated at $A4 billion in 1980. [71] Further, the shift from bare fallow to pasture cover arrested the serious problems of soil erosion.

In short, it seemed that SA had developed an alternative farming system that with low use of agricultural chemicals would be labelled as "sustainable" in today's jargon. The most in-depth and widely cited review at the time extolled the achievements and projected a bright future. It

[65] C. M. Donald, "The impact of cheap nitrogen." *J. Aust. Inst. Agric. Sc.* 26, (1960): 319-38. D. Byerlee, & J. R. Anderson, "Value of predictors of uncontrolled factors in response functions," *Australian Journal of Agricultural Economics* 13, 2 (1969): 118-27.
[66] Source: Puckridge & French, "The annual legume pasture in cereal-ley farming systems".
[67] P. G. H. Nichols, C. K. Revell, A. W. Humphries, J. H. Howie, E. J. Hall, G. A. Sandral, K. Ghamkhar, and C. A. Harris, "Temperate pasture legumes in Australia—their history, current use, and future prospects," *Crop and Pasture Science* 63, no. 9 (2012): 691-725. The estimated area under ley farming was 30 M ha including both clovers and medics. E. C. Wolfe, "Legumes, livestock and livelihoods in the Australian mixed farming system," 2013. Accessed online at https://uknowledge.uky.edu/igc/22/plenary/7.
[68] G. D. Webber, "The extension of the ley farming system in South Australia: A case study," In, *The Role of Legumes in the Farming Systems of the Mediterranean Areas*, Eds. A. E. Osman, M. H. Ibrahim & M. A. Jones (Springer, Dordrecht, 1990), pp. 257-272.
[69] C. M. Donald, "Grass or crop in the land use of tomorrow," *Aust. J. Sci.,* 25 (1963): 386-96. I am indebted to Tony Fischer for the apt description of the cascading yield curves. See also Webber et al., *Farming Systems of South Australia.*
[70] Webber et al., *Farming Systems of South Australia.*
[71] E. D. Carter, E. C. Wolfe, and C. M. Francis, "Problems of maintaining pastures in the cereal-livestock areas of southern Australia," In M.J.T. Norman. Ed. *Proceedings of the 2nd Australian Agronomy Conference.* pp. 68-82. 1982.

also concluded that "the dryland farming systems of southern Australia have the potential to increase productivity in most of the Mediterranean-type environments," notably the countries of MENA.[72] It was also recognized that the naturalized species and varieties available in Australia represented only a fraction of the genetic diversity available in their Mediterranean center of origin. The search for new species and strains in the region was already well underway.

III. Collecting the Medics

Initial contacts 1880-1910

The first systematic plant introduction for agricultural purposes in SA was undertaken by the Adelaide Botanic Gardens that had been under the leadership of Richard Schomburgk since 1865. Schomburgk, an immigrant from Germany conducted an active program to introduce new crops and varieties, above all through Kew Gardens, the apex of the British Empire network of botanic gardens. Although he received and distributed seed of cultivated forages from the Mediterranean region mainly for higher rainfall areas of SA he made little effort to target the Mediterranean region in searching for his introductions.[73] However, his counterpart at the Melbourne Botanic Gardens, Baron Ferdinand von Mueller, who had also originally migrated from Germany to SA, maintained a very active exchange with his counterpart in Algeria which had recently been colonized by the French. At the time, "acclimatization societies" were very much in vogue and the climatic similarity of southern Australian and Algeria was explicitly recognized. The French were impressed with the success of British settlement in southern Australia and regularly requested von Mueller to send potentially useful flora and fauna ranging from *Eucalyptus* species, saltbush (*Atriplex* species.) and even kangaroos.[74] There were also flows in the other direction and in 1887 von Mueller distributed seed of two 'burrless' medics noting that he had "introduced these into Australia, where in the dry hot inland regions, they have surpassed most other fodder herbs".[75]

The efforts by the botanic gardens depended on contacts to access existing collections elsewhere. Perkins in Tunisia in 1892 may have been the first to personally assemble a collection of seeds in the Mediterranean region specifically for SA. While Perkins was recruited as a viticulturalist and naturally collected vines, the letter from the colonial government of SA specifically requested shipment of forages.[76] The final shipment included 23 pasture legumes selected from seed available in the market—that is, they were already being cultivated to some extent in the region. One annual medic, black medic (*M. lupulina*) was included in his shipment and the seed was widely distributed to farmers in SA in 1892 with some success in higher rainfall areas.[77]

---

[72] Puckridge & French, "The annual legume pasture in cereal-ley farming systems".
[73] P. Payne, *Dr. Richard Schomburgk and Adelaide Botanic Garden, 1865-189*1, PhD thesis, Adelaide: University of Adelaide, 1992.
[74] R. W Home, & Sara Maroske, "Ferdinand von Mueller and the French Consuls," *Exp1orations: A Bulletin Devoted to the Study of Franco-Australian Links* 18 (1995): 3-50.
[75] The medics were *M. orbicularis* and *M. scutellata*. F. von Mueller, *Select Extra Tropical Plants Readily Eligible for Industrial Culture or Naturalization* (Melbourne: Government of Victoria, 1891), p. 273. Also see *Sydney Morning Herald* 12 Jan 1887, p. 9. There is no concrete evidence that von Mueller's samples were from Algeria but both species are natives there and he was in frequent contact with Algeria.
[76] Samuel Davenport a prominent citizen of the colony led the recruitment of Perkins had worked in southern France before migrating to SA. Davenport was interested in obtaining vines and olive seeds from the region.
[77] See P. M. Kloot, "The naturalised flora of South Australia Its manner of introduction," *Journal of the Adelaide Botanic Garden* 10, 2 (1987): 223-40.

A few years later in 1897, Perkin's colleague at Roseworthy, William C. Grassby, travelled extensively in the eastern Mediterranean in search of seed of horticultural crops such as olives, figs and vines and quite likely gathered seed of cultivated forages as well. Grassby also sought knowledge to improve management of these crops. Notably he was very impressed with the skill of the Arab farmers he met. He concluded that "when carefully examined, methods of cultivation of ignorant *fellaheen* are based on absolutely correct scientific principles."[78]

Meanwhile Perkins recognized the need to collect additional forages from the dry areas of the Mediterranean region noting in 1902:

> "For situations in which rainfall is deficient and summer heat intense no suitable plants have yet been forthcoming [in SA]…After numerous trials they [Algerian agriculturalists] abandoned attempts at acclimatisation of foreign plants and set about cultivating indigenous plants that were known to be tasteful to stock, particularly leguminous plants ….At all events [forage] plants that succeed in Algeria will succeed here and I shall endeavour to secure some."[79]

Perkins by now Professor at Roseworthy with wide responsibilities for crops and livestock returned to the Mediterranean region in 1910-1911 and travelled for one year to 6 countries or colonies as well as to the UK. Despite or perhaps because he grew up in the region, he especially disparaged Arab farm management practices but also those of the French colonists in the region. After nearly two decades in SA, his report exhibits a superior attitude on the merits of SA agricultural practices over those he visited in the region.[80] He did collect some seed, and was especially enthusiastic about one forage legume, Sulla (*Hedysarum coronarium*), and promoted it on his return.[81] However, almost a century would pass before Sulla was widely tested and promoted in SA as a "wonder legume".[82] After his extensive trip, Perkins became Director of Agriculture in SA but paid little attention to pastures and livestock as he increasingly became a "wheat man". In this capacity he may have continued to interact with French officials in the region as wheat varieties from Roseworthy were reported to be widely grown in Morocco in 1924.[83]

USDA and Russian expeditions in the early 1900s

The first efforts to collect wild medics from the Mediterranean region was undertaken not by SA but by the USDA led by David Fairchild after he was appointed as "Agricultural Explorer" in the newly established Office of Foreign Plant Introduction in 1898. Fairchild's numerous and wide-ranging expeditions over more than four decades would make him and several of his colleagues legendary in the world of plant collection and introduction.[84] USDA provided some support for international collection expeditions, but Fairchild fortuitously associated with two private philanthropists who had a specific interest in botany and plant collection. They provided

---

[78] *South Australian Register* 4 Feb 1897, p. 10.
[79] *J. of Agric and Ind.* Oct 1, 1902, p. 183.
[80] A. J. Perkins, *Agriculture in Other Lands: Notes Collected During the Course of a Visit in 1910 to Europe, Northern Africa, and Asia Minor* (Adelaide: Government Printer, 1912).
[81] *Advertiser* (Adelaide), 14 Mar 1912.
[82] ABC Rural, "Wonder legume" growing well in South Australia" 6 Nov 2013. Accessed online https://www.abc.net.au/news/rural/2013-11-07/sulla-south-australia/5075908
[83] Weekly Newsletter, Dept of Agriculture, *Southern Argus* 10 April 1924, p. 4.
[84] D. Stone, *Food Explorer*: *The True Adventures of the Globe-trotting Botanist Who Transformed what America Eats* (New York, Dutton, 2019).

generous resources for his extensive world travels including a well-appointed yacht to circumnavigate the globe in the 1920s.

Fairchild was, of course, interested in a broad array of plants for agricultural uses as well as for ornamental and scientific purposes. However, given that annual medics were being widely adopted in parts of the US as green manures and cover crops (Section II), he had a special interest in medics. "Ever since my first trip to Algeria [in 1903] to collect bur [*sic*] clovers, there has been a fascination for me in the genus."[85] He made field collection in Algeria and Spain, but his largest accessions came from botanic gardens in Algiers and Madrid.[86] On his 1903 trip he collected 24 species of annual medics as well as 40 *Trifolium* species (clovers). He made further additions on his 1924-1927 trip along with samples of *Rhizobium* root nodules. One of his USDA colleagues developed a novel but effective way of gathering seed of burr medics by wearing a coarse woolen suite and then rolling on the ground!

Fairchild's collection was extensively evaluated by USDA and one species, *M. orbicularis* was widely grown in California's sheep country where a Mediterranean climate prevailed. He delighted in his discovery of new species and their potential value, concluding that:

> "There can be no doubt that all of the native North African forage plants deserve a careful trial in the semiarid regions of the Pacific."[87]

As with the research in the US on annual medics in the early 1900s, the Fairchild collection of annual medics does not appear to have come to the notice of Australian pasture scientists until the late 1930s. In 1939, Trumble from the Waite mentions testing 20 new species of medics and these very likely came from the USDA collection since shortly afterwards he visited the plant introduction section of USDA in Washington DC.[88] The strong imperial ties between Australia and Britain undoubtedly accelerated Australia's research on pastures and ley farming but delayed its access to a potentially valuable germplasm collection in the US by several decades.

Another famed plant explorer, Nikolai Vavilov from Russia also made an extensive visit to the Mediterranean region in 1926-27. Vavilov was more scientific in his approach than Fairchild and paid much attention to diversity within species that led to his definition of centers of origin of crops based on areas of highest diversity. Vavilov defined the Mediterranean region as one of his seven (later eight) centers of origin including for forage legumes. However, Vavilov emphasized cultivated forages and only listed one wild medic in his collection.[89]

First footsteps by Australian scientists

Meanwhile, the scientific community in Australia was slowly recognizing the value of plant collection expeditions. In 1917, at the first Australian conference on agricultural research chaired by none other than SA's Perkins, Western Australia made a strong call for organized efforts at plant collection and distribution. Western Australia was making its own plans for a plant introduction center but recognized that a federal center would "lead to economy of effort and

---

[85] David Fairchild, *Exploring for Plants* (New York: MacMillan, 1931), p. 137.
[86] Bureau of Plant Industry, USDA, *Seeds and Plants Imported, Sept 1900-Dec 1903. Inventory No.10* (Washington DC: USDA)
[87] Fairchild, *Exploring for Plants,*
[88] H. C. Trumble, *Blades of Grass* (Melbourne: Georgian House, 1949). H. C. Trumble, "Barrel medic as a pasture legume," *J. Agriculture (*June 1939), 953-58.
[89] I. G. Loskutov, *Vavilov and his Institute: A History of the World Collection of Plant Genetic Resources in Russia.* (Rome: International Plant Genetic Resources Institute, 1999).

money". The USDA efforts on plant introduction were cited with specific reference to the payoffs from the introduction of durum wheat from Central Asia but with no mention of forages.[90]

Figure 5. Trumble on his exploratory trip in 1928 in Transjordania (now Jordan). He is believed to be the person in the center.[95]

At the tender age of 25 years, Trumble from the Waite was the first Australian sent to MENA to "obtain preliminary information as to the value of these regions for plant exploration …for the discovery of pasture species suitable for the semi-arid regions of the Empire" as well as to identify the best sites for collection and make appropriate contacts for such an expedition.[91] The trip was again arranged by McDougall of the EMB using his wide imperial connections, as a detour on Trumble's return to SA from his stay at Aberystwyth in 1928.[92] His visits to Palestine, Southern Rhodesia and South Africa, all part of the Empire, were logically arranged and escorted through participants in the EMB pasture project. Even the visits to Morocco and Algeria, both within the French Empire, were organized through British imperial contacts. In both cases he was able to link with British "Orientalists" resident in those countries with deep knowledge of the local Arab and Berber cultures and languages.[93] Even so, in Morocco he travelled with a French military guard to protect from "hostile Arabs".[94]

Frequently, noting the "close similarity" of rainfall and temperature data to those of Adelaide, Trumble observed that many of pasture plants in the areas he visited were identical to those naturalized in SA, including several of the annual medics. He also discovered a "new Australia" of Eucalyptus trees and other Australian flora introduced earlier via von Mueller's exchanges that were "very reminiscent of SA." Trumble did not have enough time or resources to systematically collect seeds nor was the season appropriate for seed collection. The only record of success was for seed of a Palestine strain of strawberry clover suited for high rainfall areas that he collected in Rhodesia.[96] However, based on his travels, Trumble became a strong advocate for systematic plant collection in the region noting in his trip report that the advantages

[90] G. L. Sutton, "The acclimatisation of plants," *Agricultural Research in Australia* (Melbourne: Advisory Council of Science and Industry, 1918). p. 86-95.

[91] H. C. Trumble, *Report of a Visit of Agricultural Enquiry to Palestine, Algeria, and Morocco with Particular Reference to the Natural Pastures of the Regions Visited*. Report to the EMB, 1928. Manuscript held at University of Adelaide Archives, Series 1268, Item 1. p. 2

[92] H. C. Trumble, *General Account of Twelve Months Spent Abroad*. Report to the EMB, 1928. Manuscript held at University of Adelaide Archives, Series 1268, Item 2.

[93] They were Sir Andrew Ryan, British Consul General, Rabat, and Major R.V.C. Bodley, who was living in Algeria to study Arab culture while investing in sheep production in partnership with local herdowners.

[94] Trumble, *Blades of Grass.*

[95] *Ibid.* p.

[96] It had been introduced to Rhodesia by a soldier returning from the Middle East in World War I. *Herald*, 1 Dec 1928.

of such expeditions to the Empire would be "enormous." A decade later after no follow up action he concluded:

> "It is unbelievable that Australia has not thought it worthwhile to send a well-qualified expedition to these parts for scientific study…it would result in the collection of …likely practical value in southern Australia."[97]

Anticipating later efforts by SA to export pasture technology to the region (Section III), Trumble was also asked by McDougall and the EMB to investigate the status of French efforts to establish sheep farms in North Africa that were importing the Australian Merino breed and had hired Australian farm managers, with the aim of developing a wool industry. Although McDougall and the EMB were clearly alarmed by this competitive threat to British Empire interests, Trumble concluded, prophetically as it turned out, that "it was very easy to predict that Australian [sheep] stock and methods would be destined to failure in this environment." He specifically noted the very different social and economic environment, musing that the proposed fencing of the sheep farms "would soon lead to troubles of many kinds." [98]

In 1929, a year after Trumble's trip, the Australian federal government established a Plant Introduction Section in the recently created CSIRO. The focus of this section from the beginning was on introduction of new pasture species and "ecotypes", especially legumes for both the southern areas with a Mediterranean climate as well as the northern tropical areas that were then being opened for livestock development. Although the section was modelled on the USDA's Plant Introduction Section, it depended for its first two decades on introduction by correspondence only. Since neither sub clover nor annual medics were cultivated in their center of origin in the Mediterranean basin, introductions were necessarily limited to wild ecotypes and species that had already been collected by others—that is, very few.

The need for collection expeditions for pastures continued to be echoed by scientific leaders but the onset of the Great Depression 1930 curtailed expensive exploration trips. In 1937, Otto (later Sir Otto) Frankel, then a wheat geneticist in New Zealand, delivered a lecture in Adelaide calling for international collaboration in plant collection, evaluation, and storage. Frankel who had left Austria along with many Jewish families had developed an abiding interest in genetic diversity and collection of land races and wild relatives of crops after he visited Vavilov in the Soviet Union in 1935. In the 1960s he would lead global efforts to collect and conserve plants relevant to agriculture.

Yet field expeditions would again be delayed by WWII and then by limited funds and contacts after the War. Mounting a full-scale plant collection expedition over many months required not only scientific expertise but considerable resources and local logistics. In 1947, the Plant Introduction Section of CSIRO finally mounted its first expedition by inviting itself to join an expedition being organized by USDA to collect for tropical pastures in South America.[99] Similarly, Aberystwyth connections, especially the two Davies brothers, facilitated the first collection expedition for pastures in the Mediterranean in 1951 through the Organization for European Economic Cooperation (OEEC). The OEEC had been set up to foster European integration and reconstruction after WWII with funding from the US in what became known as

---

[97] Trumble, *Blades of Grass.* p.127.
[98] *Ibid*. p. xx. Trumble, Report on a Visit of Agricultural Enquiry.
[99] R.L. Burt, and W. T. Williams, "Plant introduction in Australia," In *Australian Science in the Making,* Ed R.W. Home (Cambridge UK: Cambridge University Press, 1990).

the Marshall Plan. The OEEC Grasslands Working Party was chaired by W. Davies, formerly Imperial Grasslands Investigator at Aberystwyth with extensive experience in Australia. Meanwhile his brother, J. Davies had moved from the Waite to become principal agrostologist in CSIRO, Canberra. OEEC organized a survey mission on fodders and forages in the Mediterranean region that set the stage for the Australian collection expedition.[100]

Not surprisingly, the survey team had strong Aberystwyth and antipodean links. In the field, the team was led by Robert Orr Whyte who was raised in NZ and from 1929 had (with Stapledon) headed the Imperial Bureau of Pastures and Forages, naturally also located at Aberystwyth. Whyte had already conducted extensive surveys of Mediterranean forages in the British colonies of Cyprus and Palestine, organized a review of pasture research in Australia, and interacted with Trumble on the potential value of collection expeditions.[101] Invoking Vavilov's concepts of the Mediterranean region as a "primary centre of origination" for forages Whyte noted the potential value to Australian pastures of "gene hunting" expeditions.[102] Donald who had also moved from the Waite to Canberra to work under J. Davies was a logical addition to the team—he was already recognized as an expert on Mediterranean pasture species and as a proponent of the value of field collection in the Mediterranean region. Other members of the team included a South African who had participated in the pre-War EMB-Aberystwyth pastures project and two US pasture specialist no doubt in a nod to US financing of most OEEC activities. Conspicuously absent were representatives from the countries in the Mediterranean region, even from the French and Italian colonial powers.[103]

The OEEC team visited some eight countries and colonies and presented their report in 1951 in Rome. Not only did the trip expose Donald to a wide range of issues in pasture management in the region, but it enabled him to establish links and logistics for an immediate follow-on trip of six months to most of the same countries timed to maximize seed availability in the early summer. The OEEC report also provided legitimacy to the collection expedition by recommending that collection, evaluation and exchange of pasture germplasm be made a priority in the region. Together with a CSIRO scientist, John Miles, from the Plant Introduction Section of CSIRO, he visited 13 countries and collected 1300 field samples with the primary focus on sub clovers and medics.[104] The collection once evaluated under field conditions in southern Australia immediately established the value of such expeditions in terms of greatly increasing the diversity of species and strains then available. Two decades later, Donald counted nine released cultivars based on selections or breeding from the collections he made during his 1951 trip.[105]

This initial success combined with a rapid increase in budgets for agricultural research in the booming 1950s and the initiation of pasture breeding programs, all provided the impetus and resources for further collection expeditions in the region. High level support was ensured when

---

[100] OEEC, *Pasture and Fodder Development in Mediterranean Countries* (Paris: OEEC, 1951).
[101] Imperial Bureau of Pastures and Forage Crops, *Grassland Investigations in Australia* (Aberystwyth: Imperial Bureau of Pastures and Forage Crops, 1940)
[102] R. O. Whyte, "The phytogeographic zones of Palestine," 40(1950), 600-14. At the time of the OEEC survey, Whyte was in transition to a posting in the newly established FAO headquarters in Rome.
[103] Despite strong support from OEEC the costs to CSIRO, both in terms of budget and Donald's extended absence, were initially vetoed by his supervisor. See National Archives of Australia A9778, B1/5/35, barcode 3146104.
[104] Donald's colleague J.F. Miles independently visited four countries in the Middle East. "Search for new plants" *Queensland Country Life* 26 April 1951, p. 10.
[105] C. M. Donald, "Temperate pasture species," In R. M. Moore, ed. *Australian Grasslands* (Canberra: Australian University Press, 1970), p. 303-20.

Frankel, a leading advocate for such collections, took the position of Chief of the Plant Industry Division of CSIRO in 1951. In addition, Richard G. Casey was minister in charge of CSIRO—he had previously been British Prime Minister W. Churchill's Minister-Resident in the Middle East in WWII and was well versed in the potential value of Mediterranean pastures to Australia.[106] Indeed, it was Casey who had facilitated Trumble's travels in Morocco in 1928.[107]

Plant genetic resources as international public goods

Meanwhile, both Whyte from Aberystwyth and Trumble from the Waite moved to FAO around 1951 and established a solid scientific base for Mediterranean pastures. Whyte immediately set up an FAO Working Party on Mediterranean Pasture and Fodder Development and over the next 15 years became a very influential force for collection expeditions, naturally focused on his specialty in pastures. FAO largely through the efforts of Whyte logically became the main partner for an extensive expedition by CSIRO in 1954 as well as many later expeditions.[108] FAO could draw on a wide network of recently established country offices to provide contacts and trip logistics. The 1954 expedition was led by Cedric A. Neal-Smith who had carried out research with Donald on diversity in Australian strains of sub clover before moving from the Waite to CSIRO's Plant Introduction Office.[109] He travelled some 25,000 km in nine countries over eight months making it a much more comprehensive and systematic effort than the 1951 expedition. He also initiated efforts to sample strains of *Rhizobia* in the region.[110]

Together the 1951 and 1954 trips added immensely to the diversity then available in Australia and provided the foundation for several research programs on pasture improvement through selection and breeding. By 1959, an early strain of barrel medic collected in Cyprus had been widely distributed. Meanwhile, FAO under the leadership of Whyte was assisting countries to undertake their own collections and organizing distribution of nurseries of diverse pasture species for testing across the region. Whyte published two landmark books in the 1950s, *Legumes in Agriculture* (with Trumble) and *Plant exploration, collection and introduction* both focused on forage legumes. He also visited CSIRO in 1956 and held discussions with Frankel on international coordination of collection and storage activities. As a result of these efforts, FAO was charged by its member countries with the responsibility of coordinating and facilitating plant collection and conservation of genetic resources for the benefit of the global community.[111]

Another milestone in the early 1960s was the publication of the classic treatise on the description, cytology, and geographic distribution of the annual medics by C. Clara Heyn.[112] She

---

[106] *Farmer and Settler (Sydney)* 9 Sept 1955, p. 3.

[107] At that time, Casey was Commonwealth of Australia Liaison Officer in London. Sir Andrew Ryan, British Consul General, in Rabat, Morocco, was Casey's uncle. See Trumble, *Blades of Grass*.

[108] On the CSIRO side, both Frankel and Donald were the main contacts The lead up negotiations to this expedition are described in detail in the National Archives of Australia A9778, B1/5/36, barcode 3146105.

[109] C. M. Donald & C. A. Neal-Smith, "Strain variation in subterranean clover," *J. Council for Scientific and Industrial Research* 10 (1937) 277-90.

[110] C. A. Neal-Smith, *Report on Herbage Plant Exploration in the Mediterranean Region, March 1-Oct 15, 1954*, Report No 415 (Rome: FAO, 1955).

[111] R. Pistorius, *Scientists, Plants and Politics: A History of the Plant Genetic Resources Movement* (Rome: IPGRI, 1997). R. O. Whyte, *Plant Exploration, Collection, and Introduction* (Rome: FAO, 1958).

[112] C. C. Heyn, *The Annual Species of Medicago* (Jerusalem: Magnes Press, Hebrew University, 1963). By 2001, 49 annual species were recognized and another 20 were later added from the *Trigonella* family. See J. Prosperi, G. Auricht, G. Génier, and R. Johnson, "Medics (Medicago L.)," In *Plant Genetic Resources of Legumes in the Mediterranean*, eds. N, Maxted & S. J. Bennett (Dordrecht: Springer, 2001). pp. 99-114.

had immigrated to British-mandated Palestine prior to WWII and as a professor of Botany at Hebrew University was the leading expert on the wild medics of the region and later for Mediterranean flora, more generally. Heyn recognized 28 annual species of which only eight had earlier been naturalized in South Australia.[113] Her interest was motivated by the growing effort in inter-specific hybridization to improve the world's most widely grown fodder species, *Medicago sativa,* the perennial lucerne (or alfalfa in the Americas). Nonetheless, her book became an essential reference for Australian scientists collecting and breeding medics.[114]

From 1965, CSIRO's Frankel engaged with FAO to strenuously promote international efforts to conserve genetic diversity of crop species. The concept of genetic erosion—the permanent loss of land races and wild relatives of crops due to replacement by "modern varieties" and degradation of natural ecosystems by humans—added further urgency to efforts at plant collection and conservation. When Whyte left FAO, Erna Bennett, a British-Irish geneticist experienced in plant collection in the Mediterranean region and a strong advocate for *in situ* conservation collaborated with Frankel in a 1967 conference. They published the proceedings, *Genetic resources in plants: their exploration and conservation* regarded as a turning point in the global conversation about genetic resources. Arguably, the Australian interest in Mediterranean forages from the early 1950s had stimulated FAO interest and global leadership in the emerging area of genetic resources.[115]

Meanwhile, eight further Australian expeditions were mounted for Mediterranean forages from 1955 to 1971 together covering nearly all countries of the Mediterranean region as well as Chile. Scientists from the Waite Institute and SADA led half of these usually with logistic support provided by FAO. By 1960, Eric Crawford of SADA had set up a gene bank emphasizing annual medics and in 1967 he mounted a collection expedition focusing on medics.[116] Other opportunities were also exploited such as an expedition to southern areas of the Soviet Union and Iran in conjunction with attending a conference in Moscow in 1974.[117] SADA even placed an advertisement in an FAO newsletter announcing that "South Australian Pasture Breeders Seek Medicagos".[118] By the 1980s the small gene bank in Adelaide had evolved into the Australian Medicago Genetic Resources Center with 16,000 accessions of annual medics alone, the largest and most comprehensive collection in the world.[119] It is now recognized as the world's "base collection" for medics.[120]

---

[113] J. M. Black, *The Naturalized Flora of South Australia* (Adelaide: J. M. Black, 1909)
[114] Another Israeli scientist, Joseph Katznelson also became an important CSIRO collaborator in collecting the medics in the region.
[115] Pistorius, *Plants, Science and People.*
[116] E. J. Crawford, "General report on overseas pasture seed collection mission-April-August, 1967," *Plant Introduction Review* 4, 2 (1967), 25-31. E. J. Crawford, A. W. H. Lake, & K. G. Boyce, "Breeding annual Medicago species for semiarid conditions in southern Australia," *Advances in Agronomy* 42 (1989): 399-437.
[117] Annual report, Agronomy Branch, SADA, 1974. Accessed online at https://digital.library.adelaide.edu.au/dspace/handle/2440/10779
[118] FAO, Plant Genetic Resources Newsletter No 25, Jan 1971, Rome.
[119] Since 2015, merged into the Australian Pastures Genebank, also headquartered in Adelaide.
[120] Western Australia also became very active in collection expeditions. Its scientists emphasized *Trifolium* species since they were more relevant to that state, and established the Australian Trifolium Genetic Resources Center, again a world base collection. These efforts were led by Clive M. Francis who, remarkably, conducted 12 collection expeditions to 10 countries, a feat that was recognized by the Russians when he received the Vavilov Institute Memorial Medal in 1999.

The 1970s witnessed a power struggle between FAO that had built its political legitimacy to lead efforts to conserve genetic resources but lacked the financial resources to do so, and the newly created CGIAR that was heavily investing in plant breeding of food staples in a number of its international agricultural research centers, including several large gene banks.[121] An effort was made to alleviate these tensions in 1974 by creating the International Board for Plant Genetic Resources (IBPGR) that was an independent "hybrid" financed by CGIAR and hosted and staffed by FAO. As discussed later, the International Center for Agricultural Research in the Dry Areas (ICARDA) was founded by CGIAR in 1977 to serve the needs of MENA. Under the auspices of the IBPGR, ICARDA's forage program built its own collection of forage legumes from the region.[122] From its beginnings, ICARDA collaborated closely with scientists from Australia in organizing several collection expeditions on forages—indeed its forage program was ably led for much of the 1980s by a senior scientist recruited from SADA, Philip S. Cocks.

Given the continuing interest by Australia and FAO, many countries in the region began to appreciate the potential value of the large number and diversity of wild legume species growing throughout the region. This was especially so after 1970 when Australian institutions began to promote their dryland farming systems using pasture legumes originating in the region. In 1976, the Libyan government financed a very comprehensive country collection of medics that was coordinated by FAO with technical support from SA, and WA.[123] The Moroccans led a pioneering effort to define species and "ecotypes" of indigenous medics in terms of climate and soils. Countries on the north side of the Mediterranean stored collected forages in gene banks to serve the region.[124] By the 1970s, collection expeditions for Mediterranean pastures had become routine, with a total of 44 by 1990 and as many as 90 by the most recent count.[125]

Notably absent in the collections by both local scientists and the Australians was any effort to record indigenous knowledge related to the ecotypes collected. Local shepherds had surely accumulated a great deal of knowledge of the seasonal availability, palatability and other traits of the highly diverse natural pastures that supported their livelihoods. Only from the 1990s with the movement to farmer participatory research and then spurred by the UN Declaration on the Rights of Indigenous Peoples in 2007 has indigenous knowledge of pastures started to receive some attention.[126]

---

[121] H. A. Curry, *Endangered Maize, Industrial Agriculture and the Crisis of Extinction* (Oakland, CA: University California Press, 2022).

[122] IBPGR initially prioritized collections and conservation of food crops, but by 1980 had prioritized collection of medics from the Mediterranean region. IBPGR hired a coordinator for forage collections, yet another Davies (W. Ellis) from Aberystwyth,

[123] The FAO agronomist was Gustave Gintzburger from France who later moved to Western Australia to manage a novel accelerated evaluation of the collection in Libya in the northern winter and Australia in the southern winter

[124] R. Sackville Hamilton, S. Hughes, & N. Maxted, "Ex Situ conservation of forage legumes," In N. Maxted & S. J. Bennett, eds. *Plant Genetic Resources of Legumes in the Mediterranean* (Springer Science & Business Media, 2001). pp. 263-291.

[125] R. W. Smith., C. A. Harris, Kendrick Cox, D. McClements, S. G. Clark, Z. Hossain, and A. W. Humphries, "A history of Australian pasture genetic resource collections," *Crop and Pasture Science* 72 (2021): 591-612.

[126] D. K. Davis, "Indigenous knowledge and the desertification debate: Problematising expert knowledge in North Africa," *Geoforum* 36.4 (2005): 509-524. N. Naghizadeh, H. Badripour, M. Louhaichi, M. Gamoun, M. Niamir-Fuller, "Rangelands and pastoralism of the Middle East and North Africa, from reality to dream," In *Proceedings Joint XXIV International Grassland and XI International Rangeland Kenya 2021 Virtual Congress*, 2022. Accessed online https://uknowledge.uky.edu/igc/24/.

Reaping the benefits

The great majority of collection expeditions were led by Australian scientists and financed by Australian federal and state governments. The costs have been considerable, but the benefits to Australia have undoubtedly far exceeded the costs. By 1990 over 80 percent of medics released in Australia were from introductions made since 1950, originating from 17 different countries, and several additional species of medics had been "domesticated".[127] Improved cultivars developed by breeding programs drawing on the increased diversity of genetic resources available from the collections have also become common. These cultivars have enabled pasture legumes to be adopted in new agro-ecological niches as well as to improve productivity and stability in already established areas. They were widely adopted since it was a simple task for farmers to substitute newer varieties for those they already used in their farming system.

Australian farmers and consumers have been the main beneficiaries of these efforts. At first glance this might appear to be a prime example of the Global North freely using the genetic resources of the Global South, in this case somewhat incongruously represented by South Australia and North Africa, respectively. By 1990, these North-South tensions had become center stage in the ownership of genetic resources.[128] However, as early as the CSIRO/FAO 1954 collection expedition, a long series of correspondence between FAO with CSIRO was needed to ensure agreement that a duplicate of the collection would be quickly shared with the countries of the region through FAO in anticipation that they would be of great value for developing more productive farming systems in the region.[129] Another factor muting controversy may have been the many efforts to "return" the cultivated medics in the form of improved dryland systems—the subject of the next section.

IV. Returning the Medics

Recognizing an opportunity

During the colonial era in North Africa there had been a long debate on agricultural intensification, the reduction of fallow, and the extent of land degradation in both the cereal areas and rangelands. As described in Susan Davis's book, *Resurrecting the Granary of Rome,* much of this was used by the French to justify privatization of land, control of pastoralists, reforestation, and most importantly, as a rationale for European settlement. The 1951 OEEC survey of eight Mediterranean countries by Donald, Whyte and others (Section III) was carried out against this colonial backdrop, and indeed, the French territories in North Africa had yet to achieve independence. Not surprisingly the OEEC report echoed many of the same ideas. In particular, the team stressed the importance of replacing fallow with pastures in order to reduce grazing pressure in the rangelands. They concluded that the "the most adverse features of the farming system is the almost complete lack of integration of crop and livestock husbandry."[130]

---

[127] E. J. Crawford, A. W. H. Lake, and K. G. Boyce, "Breeding annual Medicago species for semiarid conditions in southern Australia," *Advances in Agronomy* 42 (1989): 399-437. E. J. Crawford and G. C. Auricht, "Australian contributions to the conservation of medic germplasm," In S. Christiansen, L. Materon, M. Falcinelli, P. Cocks (eds) *Introducing Ley farming to the Mediterranean Basin: Proceedings of an International Workshop*. (Aleppo, Syria: ICARDA 1993).
[128] See for example, C. Fowler, *Unnatural Selection: Technology, Politics and Plant Evolution*. (Reading: Gordon and Breach, 1994).
[129] National Archives of Australia A9778, B1/5/36, barcode 3146105
[130] OEEC, *Pasture and Fodder Development in Mediterranean Countries.* p. 12.

Noting the very similar climatic conditions to SA, Donald drew attention to the emerging success in southern Australia in incorporating pasture legumes into the rotation and its potential use in MENA but "appreciated technical and sociological differences of adopting these practices in areas in which farm units are very small."[131]

The economic and institutional environments were indeed quite different. In SA, reflecting its history of highly organized settlement, these conditions were quite uniform across the state. Most farmers owned both land and livestock and managed them jointly as part of a system that relied on fencing to control grazing and protect crops. Farms were large with an average size of 900 ha and 1200 sheep in 1970, wages were high, and most farm operations were mechanized.[132] Markets were well developed including financial markets. By contrast, in MENA farm size was relatively small (most commonly from 10 to 50 ha[133]), often fragmented, labour was cheap, and mechanization was limited. Land tenure varied widely from private ownership, customary, individual, and collective tenure, and after independence, cooperatives and state farms that took over farms of European settlers. As a result of this diversity of tenures there were also many large farms in MENA. Most importantly, although crop farmers often owned a small household flock, management of most livestock was in the hands of specialized herders, often nomadic, who by traditional law enjoyed open grazing rights on any land that was not under crop, including cropland in the fallow phase. Recognizing and addressing this diversity of farm size and tenure situations would be central to the challenge of introducing Australian dryland systems over the next four decades.

During the 1950s with the movement to independence, FAO became an important player in the region. Whyte in addition to coordinating FAO efforts to collect pasture species (Section III) organized "Working Parties" on pastures and fodders for the region that distributed forage nurseries, including medics collected locally as well as medics introduced from Australia. Another FAO agronomist, Peter Oram, who had collected forages with the FAO/CSIRO expedition in 1954 in Libya was commissioned to design options for experimentation on crop rotations with forages.[134] He advocated testing alternatives that included grain legumes, green manures, and forages for cut fodder and forages for grazing, especially sub clover and medic. He also noted the complication of "shepherds with no land and cultivators with no animals" and that "management may well prove the nemesis of sown pastures in the Mediterranean."[135] Other FAO "experts" including some from Australia also continued with more in-depth country studies of forages all within the overarching aim of substituting productive pastures for fallow. [136]

In 1960, FAO endorsed what became known as the UN Mediterranean Project being promoted by Gunnar Myrdal, a noted Swedish social scientist and later winner of the Nobel Prize in Economic Sciences. The central idea of the project was "the integration of agriculture and

---

[131] *Ibid,* p. 132
[132] E. D. Carter, *The Potential for Increasing Cereal and Livestock Production in Algeria.* (Mexico, D F: CIMMYT, 1975).
[133] P. J. M Cooper, P. J. Gregory, D. Tully, and H. C. Harris, "Improving water use efficiency of annual crops in the rainfed farming systems of West Asia and North Africa," *Experimental Agriculture* 23, 2 (1987): 113-158.
[134] P. A. Oram, *Pastures and Fodder Crops in Rotations in Mediterranean Agriculture* (Rome: FAO, 1956).
[135] *Ibid,* p. 30
[136] For example, G. Perrin de Brichambaut in Rome, and M. Thault in Tunis. For an FAO consultancy from CSIRO see E.T. Bailey, *Report to the Government of Jordan on Pasture and Fodder Plant Introductions and Establishment Problems* (Rome: FAO, 1967).

animal husbandry" again through replacement of fallow by forages.[137] The Mediterranean Project had ambitious plans to attract donor investment but lacking funding, the main output was a series of detailed studies on climate and land use. The climatic similarity of the countries of the Mediterranean region to other regions of the world, including southern Australia, was highlighted through detailed maps of climate and vegetation.[138]

Another significant effort to tap Australian knowledge and technology was made by Micheal Y. Nuttonson in the 1950s. Nuttonson had studied under Vavilov in the Soviet Union in the 1920s before emigrating to Palestine and then the US, as part of the Jewish exodus from Russia. Pre-empting the agricultural science profession by decades, Nuttonson was fixated on developing "agro-climatic analogues" to efficiently transfer technology across countries and continents. For example, his concepts and data were employed by USDA in the direct transfer of US maize hybrids to Europe immediately after WWII. [139] He then established his own non-profit center to market his services and in this capacity was hired by the government of Israel in 1958 to review Australian experience in Mediterranean agriculture for relevance to Israel. After an extensive visit he prepared an encyclopaedic volume of 1250 pages that included a chapter on Mediterranean forages grown in Australia. On sub clover he observed "the strange thing is that lands from which it originated still appear to have no use for it", ignoring the fact that although not cultivated, it was probably an important component of natural pastures in many areas.[140] Soon after Israeli scientists initiated a modest research effort on rotations with pasture legumes in a crop-livestock system.[141]

Enter CGIAR

The international agricultural research centers of what became CGIAR were the first to actively promote the Australian ley farming system in the region motivated by their mission to use science to feed the world. In 1960 Norman E. Borlaug, the head of wheat research in the Rockefeller Foundation in the Americas was asked to review an FAO regional program on wheat and barley breeding in MENA that had operated for a decade. Borlaug travelled extensively in the region to observe wheat research, noting that not only Gabo, a variety from Australia was extensively grown but his own wheat varieties from Mexico (many of which had Gabo parentage) were also performing well.[142] This experience stimulated his interest in the potential of broadly adaptable wheat varieties as opposed to the prevailing view that breeders should aim at specific adaptation.

Shortly after, Keith W. Finlay, a plant breeder at the Waite, co-authored a seminal paper on adaptability of a global collection of barley varieties in SA.[143] Not only did this show the superiority of North African varieties in SA but it demonstrated a simple statistical method for

---

[137] E. Glesinger, "The Mediterranean Project," *Scientific American* 203 (1960): 85-105.
[138] UNESCO-FAO, *Bioclimatic Map of the Mediterranean Zone* (Paris: UNESCO, 1963).
[139] D. Byerlee, "Globalization of hybrid maize," *J. of Global History* 15 (2020): 101-122.
[140] M.Y. Nuttonson, *The Physical Environment and Agriculture of Australia, with Special Reference to Its Winter Rainfall Regions and to Climatic and Latitudinal Areas Analogous to Israel* (Washington: Institute of Crop Ecology, 1958). p.577.
[141] E. Eyal, R. W. Benjamin, and N. H. Tadmor, "Sheep production on seeded legumes, planted shrubs, and dryland grain in a semiarid region of Israel," *Journal of Range Management* 28 (1975): 100-107.
[142] N. E. Borlaug. Observations made by Norman E. Borlaug on the FAO Near East Wheat and Barley Project, March 6th through May 9th, 1960. Borlaug papers, CIMMYT, Mexico, 1960.
[143] K. W. Finlay, and G. N. Wilkinson, "The analysis of adaptation in a plant-breeding programme," *Australian Journal of Agricultural Research* 14 (1963): 742-754.

measuring adaptability. The paper caught the attention of Borlaug for its practical applications in his international wheat breeding program.[144] Finlay interacted extensively with Borlaug over the next few years and invited Borlaug to deliver the keynote address to the International Wheat Genetics Symposium in Canberra in 1968. There Borlaug expressed his admiration for the Australian dryland ley farming system "hoping to see the day when the knowledge and skills you have developed…are transplanted back to North Africa and the Middle East where they are so badly needed."[145] Borlaug recommend that CIMMYT hire Finlay which it did as its Director for Basic Research in 1969.[146] As its first Australian scientist Finlay's appointment ensured a lead role for South Australian scientists in CGIAR work in MENA for the next two decades.

Meanwhile, the Ford Foundation had begun supporting research in MENA and asked CIMMYT to strengthen research capacity on dryland wheat in North Africa. With his background in breeding for drylands in SA, Finlay became actively engaged in this program and asked John B. Doolette, a senior agronomist in SADA, to review the potential for SA dryland farming system in North Africa. In a narrow technical report that largely ignored the complexity of introducing a new farming system, Doolette enthusiastically supported a research program to evaluate medics in place of fallow. Shortly after in 1971 he moved to Tunisia with CIMMYT to implement the program. Finlay also contracted a SA colleague from the Waite, Edward (Ted) Carter, a pasture agronomist, to review the potential for medics in Algeria. In his report, Carter noted that "it was soon obvious to me that there were striking ecological similarities between Algeria and southern Australia and that Australia had a great deal to offer in…the science and technology related to cereal and livestock production and integration.[147] CIMMYT then recruited a second agronomist, again from SADA, to introduce the SA farming system to Algeria.[148]

These programs, especially the Tunisian program, soon demonstrated the technical potential of ley farming using a rotation of medic varieties directly imported from SA to substitute for use of nitrogen fertilizer in wheat, although no livestock component was included.[149] By 1975 with the oil shock and a nearly ten-fold increase in the price of nitrogen fertilizers, CIMMYT was ready to show case its efforts. A glossy CIMMYT report, *Return of the M* Figure 6. SA farmer-members of SeedCo at Port Adelaide to farewell the shipment of 5,000 tons of their seed, much of it medic seed, to Libya in 1977.[150]*edic,* highlighted the rapid progress and concluded that "the cereal legume rotation is a bold stroke…that could improve the lives of millions." Indeed, the main constraint was lack of sheep to graze the newly established pastures with Doolette noting that income from sheep would be "the cream on the jam."[151]

---

[144] M. Baranski, *The Globalization of Wheat: A Critical History of the Green Revolution* (Pittsburgh PA: University of Pittsburgh Press; 2022).
[145] N. E. Borlaug, "Wheat breeding and its impacts on world food supply," In *Proceedings of the Third International Wheat Genetics Symposium* (Canberra: Aust. Academy Science, 1968).
[146] Memo by Norman E. Borlaug to Robert Osler, 1 August 1968. University Minnesota Archives, Norman E. Borlaug Papers, Correspondence, 1954-2006. Chronological Correspondence. (Box 3, Folder 7).
[147] Indeed, he estimated that Australian methods could be adopted on five million ha provisioning an additional 10 million sheep. E. D. Carter, *The Potential for Increasing Cereal and Livestock Production in Algeria* (Mexico, DF: CIMMYT, 1975), p v.
[148] David Saunders, a student of Carter
[149] Higher altitude areas of Algeria with a colder climate required a search for local cold-tolerant medics
[150] Source: Badman & Farnan, *SeedCo, Seeds of Success*
[151] Breth, *Return of the Medic*

A conference sponsored by CIMMYT and FAO in 1975 in Tunisia gave special attention to the unfolding promise of the new rotation and system. The keynote address for this session was delivered by Borlaug who against the backdrop of escalating prices of nitrogen fertilizer made a passionate call for investment in fertilizer manufacturing capacity. Characteristically, he also delivered a broadside against organic farming although he noted parenthetically that "(this is not meant to ignore the important use of legumes)."[152] The following presentations led by Doolette unanimously endorsed the potential of the ley farming system.[153] A Ford Foundation delegate, not coincidentally another Australian agronomist, estimated the huge potential of sowing medics in the region concluding that "the rotation could be introduced with a minimum of adaptive work and with maximum results"[154] Only R. Glenn Anderson, Borlaug's deputy in CIMMYT sounded a note of realism on the complexity of introducing the system, given separation of management of crops and livestock.

As CGIAR expanded rapidly in the 1970s it explored the potential of a regional center for dryland agriculture in MENA to address a gap in its research portfolio and to attract funding from countries in the region growing wealthy from the oil boom. In 1973, the Technical Advisory Committee (TAC) of the CGIAR, chaired by Australian economist, John C. (later Sir John) Crawford, commissioned a team to explore the feasibility of such a center. Crawford was well aware of the Mediterranean 'agro-climatic analogue' and employed Carter from the Waite as a member of the team.[155] Oram from FAO who had moved to become the Secretary of TAC also joined the team bringing his two decades of experience with forages in MENA. Their extensive report recommended the establishment of what became the International Center for Agricultural Research on the Dry Areas (ICARDA) with one of its priorities to conduct research on forage legumes including the application of the "Australian model."

As ICARDA was being set up in 1977, it brought Carter back again for an extensive survey across the region on research priorities on legumes. Visiting some ten countries over a three-month period his report largely ignored food legumes and drawing on the experience of the Australian and FAO programs that had been initiated in several countries, strongly promoted research on ley farming with medics.[156] He carefully quantified the potential in terms of 23 million hectares of farmland suited to the cereal-pasture legume system that could produce 86 million *additional* sheep and 1.4 million tons of nitrogen for the following cereal crop. As in his previous visits, his report heavily emphasized the technical side although vaguely noting that it

---

[152] N.E. Borlaug, "The role of fertilizers—especially nitrogenous—in increasing world food supply," In *Proceedings of the Third Regional Wheat Workshop, April 28-May 2, 1975* (Mexico, DF: CIMMYT, 1976), p. 224.
[153] Doolette concluded that the system was technically possible and "assumed it would be economically sound". J. B. Doolette, "The strategy of establishing a crop rotation programme using annual forage legumes," In *Proceedings of the Third Regional Wheat Workshop.*
[154] D. W. Leeuwrik, "The relevance of the cereal-pasture legume rotation in the Middle East and the North African Region." In *Proceedings of the Third Regional Wheat Workshop.* Ironically, the Foundation had launched its program in MENA five years earlier by commissioning a major report that emphasized the "social, cultural and institutional requisites" for improving grazing management. See M. Clawson, H. H. Landsberg, & L. T. Alexander, *The Agricultural Potential of the Middle East* (New York: American Elsevier Pub, 1971).
[155] Crawford and Donald had worked closely in the Department of War and Industry during the War and Crawford likely asked Donald to join the team or suggest a colleague.
[156] Carter observed results of some of the medic research started years earlier with FAO and now led by national scientists, especially the strong program at the University of Mosul, Iraq. E. D. Carter, *A Review of the Existing and Potential Role of Legumes in Farming Systems in the Near East and North Africa* (Mimeo) (Aleppo, Syria: ICARDA, 1978).

would require a “delicate blend of political, social, economic and technical expertise.”[157] ICARDA was impressed by the numbers and ley farming became the core of ICARDA’s research on forages and farming systems in its first decade. Doolette transferred from CIMMYT to ICARDA to initiate the work. ICARDA did recognize from the outset that it should seek to transfer the ley-farming concept rather than the system *per se* and over time, with a much larger team, initiated long-term research on rotations that integrated livestock. As already noted (Section III), collection of forage legumes and *Rhizobia* from the region was also a core activity of ICARDA that fed into forage breeding activities. Even so, the research still lacked a broader systems perspective and socio-economic input.[158]

South Australia’s adventures in MENA

In contrast with the science-driven motivation of the CGIAR initiatives, the entry of SADA and allied private industries from SA was “demand driven” oriented by commercial interests on the SA side and agricultural development and food security objectives on the part of countries in MENA. In total SADA signed contracts in four countries to demonstrate and extend ley farming but through FAO and study tours, its influence extended widely throughout the region. Arthur Tideman, one of the main protagonists from SADA, has described these projects in some detail in his book, *The Medic Fields*, including some assessment of their payoffs—at least to SA.

Figure 6. SA farmer-members of SeedCo at Port Adelaide to farewell the shipment of 5,000 tons of their seed, much of it medic seed, to Libya in 1977.[159]

The first contacts were made by Bashir Jodeh, the dynamic young director of the Jebel El Akhdar Authority (JAA) in north-eastern Libya. Jodeh had studied in Western Ausralia and travelled extensively in the farming areas of southern Australia. Flush with oil revenues in the 1970s, the JAA had been set up by Libya’s leader Colonel Muammar Gaddafi as part of his “Agricultural Revolution” program. With an annual budget of US $300 million (equivalent to the *total* budget of the government of SA), JAA aimed to develop agriculture in a marginal dryland environment through the settlement of some 2000 medium-size farmers of about 80 ha each. Farmers were expected to follow the ley farming methods aided by fencing to control entry of livestock from outside. In 1973 JAA contracted with the South Australian Seedgrowers Cooperative Ltd (SeedCo) to supply pasture seed and to send an average of eight SA farmers per year to provide short-term training to Libyan farmers. SeedCo had already been very entrepreneurial in moving into a risky and unknown market in MENA. It established

[157] *Ibid,* p. 76.
[158] Much of this section is based on the External Management and Program Reviews conducted by the CGIAR of ICARDA in 1984, 1988, 1993 and 2000, available at https://cgspace.cgiar.org
[159] Source: Badman & Farnan, *SeedCo, Seeds of Success*

ambitious targets for selling seed throughout MENA often of medic varieties originating from recent Australian collections in the region (Figure 6).[160]

In addition, JAA requested SADA to set up a 1000 ha demonstration and adaptive research farm. The SA Premier Don Dunstan (the state's highest political position) enthusiastically agreed, seeing opportunities for new markets for SA products beyond seed, such as farm machinery, fencing materials and sheep. Although representing the left-of-center Labor Party he was keen to "involve ourselves in business"[161] That SADA would agree to a project in a "socialist state" half a world away reflected a recent radical change in SA political leadership from a staid conservative government in office for over three decades to a liberal minded and socially oriented government headed by Dunstan. Growing up in Fiji, Dunstan was interested in international affairs having already gained experience in MENA through a fact-finding mission on the Cyprus conflict.[162]

The JAA demonstration farm was essentially a "turnkey project" to replicate a large Australian farm (Figure 7). Wheat and medic varieties, machinery, fences as well as sheep, a shearing shed and even shearing instructors were all imported from SA. With paddocks (fields) named kangaroo, kookaburra, and koala, one agronomist recalled that "we were trying to treat farm."[163] Generous funding allowed JAA to hire the needed expertise from SADA to implement the project under the competent leadership of Jodeh.[164]

Dunstan himself made an extended trip to Libya and the region in 1978 and endorsed a search for further such projects. In doing so, he was strongly supported by his agricultural minister, Brian Chatterton. Self-described as a member of the SA "landed gentry" Chatterton had studied agricultural science in the UK and managed the family's farm and vineyard before entering politics.[165] He invariably worked as a team with his wife, Lynne Chatterton, a political scientist described as having a "forthright style" and who was a close adviser to Premier Dunstan.[166] The Chattertons became outspoken champions of ley farming methods after they made an extended visit to the region in 1979—indeed it became their passion. They recognized the challenge posed by separate ownership and management of crops and livestock but advocated fencing (as in Libya) and cooperatives to manage grazing of pastures.[167] Rather than changing the system to fit the institutions they argued for the much more difficult task of changing the institutions to fit the system, a position they would hold for the next two decades.

Dunstan, the Chattertons, and SADA more generally, saw the Libyan project with extensive areas of medics imported from SA growing on both the demonstration farm as well as by many

---

[160] R. H. Badman & P. A. Farnan, *SeedCo, Seeds of Success: A 25 year history* (Adelaide: Lutheran Publishing House, 1988).
[161] D. Armstrong, "Libyan deal takes the heat off Dunstan," *The Bulletin* Aug 9, 1977, p. 78.
[162] A. Woollacott, *Don Dunstan: The Visionary Politician who Changed Australia* (Sydney: Allen & Unwin, 2019).
[163] T. Dillon & K. Bicknell, Australian demonstration farm, El Marj: Report on operations for 1975/76. Agronomy Branch, SADA, Adelaide, 1976. Interview with Peter Barrow on 30 March 2004 in regard to the history of SADA. Accessed online at https://history.pir.sa.gov.au/__data/assets/pdf_file/0006/48597/Barrow_peter_int.pdf
[164] Tideman, *The Medic Fields.*
[165] B. Chatterton, *Roosters and Featherdusters* (Renwick, N.Z: Pulcini Press, 2003).
[166] *Canberra Times,* 1 May, 1983, p.2.
[167] B. Chatterton and L. Chatterton, *Report on Rainfed Cereal and Livestock Production in West Asia and North Africa: Following a Mission by the South Australian Minister of Agriculture* (Adelaide, Mortlock Library, 1979).

individual farmers as "highly successful" and a shining example for the whole region.[168] SADA released a glossy booklet, *The Libya story: Food from an empty bowl* complete with color photographs showcasing its achievements in Libya. Not to be outdone, Jodeh (as well as Ghadaffi) saw Libya as a leader in dryland farming in the region and produced an impressive coffee table book, *Harvest for all seasons in Jebel El Akhdar,* illustrating its progress (Figure 7). Both books were published in three languages—Arabic, English and French—to present to the growing number of international visitors to JAA to learn from the ley farming experience.

Figure 7. Stylized picture of Libyan leader M. Gaddafi in a wheat field grown in rotation with medics in the Jebel Al Akhdar project.[169]

Still there were clouds on the horizon. The future of the SADA demonstration farm in Libya was never clarified but judging by a parallel Western Ausralian project in the western side of the country, it was to be broken up into private farms, a process that was managed disastrously in the 1980s.[170] Sales of seed and machinery were significant in the early years but with declining oil prices Libyan revenues to fund the project and purchase farm inputs dried up. The farmer-to-farmer extension seems to have had some success in improving crop management and maintaining machinery but by SeedCo's own assessment much less so in explaining the more complex management decisions on grazing and self-seeding of the medics—especially given the Australian farmers' lack of skills in even basic Arabic. As Lynne Chatterton reflected, "when the Australian farmers left around 1980, the Arab farmer had to manage without the helpful friendly Australian farmer who could be called in to remind and repair, and they often gave up in despair."[171] Jodeh's promotion to minister of agriculture followed by his untimely death in 1983 largely ended the effort on dryland farming systems in Libya based on the Australian model.

The Chattertons and others who extolled the success of the Libyan project during its heyday, failed to recognize its unique historical legacy that negated its wider relevance in the region. The

[168] B. Chatterton & L. Chatterton, "The Jackson report and agricultural aid," In *Australian Overseas Aid.* P. Eldridge, D. Forbes & D. Porter, eds (Surrey Hills, NSW: Croom Helm, 1986) p. 171-90.
[169] Source: JAA, *Harvest for All Seasons.*
[170] N. Halse, "Lessons from attempts to transfer farming technologies from Mediterranean Australia in West Asia and North Africa", In *Agricultural Technology: Policy Issues for the International Community.* Jock R. Anderson, ed. (Wallingford: CAB International, 1994) p. 304-20.
[171] Lynne Chatterton, *Red Herrings* (Renwick, N.Z: Pulcini Press, 2001).

project was built on the push in the 1930s by Benito Mussolini, Italy's Fascist leader, to settle Italian farmers in the area by brutally expelling the Bedouin herders.[172] After the War, the departure of the Italian colonists left a legacy of individual farms enclosed by fences. The abandoned farms were then transformed into a settlement project for Libyans, many of them descendants of the original displaced Bedouins who were familiar with livestock. The size and number of farms was further expanded by the Ghaddafi government's policies to enclose remaining uncultivated grazing land suitable for farming. These settlers were provided extremely generous financing, machinery, and inputs, drawing on the ample resources of the JAA.[173] In short, land tenure, farm size, experience with livestock, and access to JAA services were very atypical of the region as a whole.

Back in SA there was also grumbling by its farmers about the extended absence of SADA technical staff given SADA's very small cadre of less than 50 agronomists and extensionists.[174] The Libyan and other projects in MENA employed over 100 person years of SADA expertise over the decade, a significant share of SADA's human resources. Further, the federal government was unhappy about a state government running what seemed its own foreign assistance and diplomacy efforts in a politically sensitive region and with what was increasingly seen in the West as a "rogue state." Indeed, B. Chatterton was seen by some as a "stooge" of Gaddafi.[175]

FAO continued to run its own regional and country projects to promote ley farming often in close cooperation with SA.[176] In 1974, the FAO coordinator for the regional cereals project visited Australia and became an enthusiastic convert to the Australian farming system.[177] This was followed by many "study tours" for regional scientists to Australia. The most ambitious FAO program (funded by Saudi Arabia) sent some 50 agronomists from the region to Roseworthy from 1976 to 1980 to complete a one-year post-graduate diploma in dryland farming systems.[178] Aided by these exchanges, national leaders emerged who led research on ley farming and medics in countries where SADA was not directly engaged.[179] There is some indication that they were more attuned to the challenges of introducing the system in a very different social and economic context.[180]

After their 1979 trip, the Chattertons planned the 1980 international dryland farming congress in Adelaide described at the beginning of this paper. This was probably the largest international agricultural congress held to date in Adelaide but ironically, the Labor Party was voted out of office before the congress so neither Dunstan (who had already resigned) nor Brian Chatterton

---

[172] For an analysis by a distinguished anthropologist, see E. E. Pritchard, "Italy and the Bedouin in Cyrenaica," *African Affairs* 45, 178 (1946): 12-21.
[173] FAO, *Report to the Government of Libya on Development of Tribal Areas and Settlement Project,* FAO/LIB/TF20. (Rome: FAO, 1969).
[174] Interview with Jim McColl on 9 Oct 2003 in regard to the history of SADA. Accessed online at https://history.pir.sa.gov.au/__data/assets/pdf_file/0005/16439/mccollint.pdf
[175] Chatterton, *Roosters and Featherdusters*.
[176] FAO country projects in Algeria and Syria, were managed by an Australian agronomist, R. Gallacher, formerly of the Victorian Department of Agriculture.
[177] FAO, Report of the national task force leaders study group to Australia and New Zealand (Cairo: FAO Near East Regional Office, 1975).
[178] Daniels. *A Century of Service*
[179] Notably M. Bounejmate in Morocco, M. N. Bakhtri in Algeria, and A.K. Al Fakhry in Iraq.
[180] See, for example, M. N. Bakhtri, *Cereal Annual Lucerne Rotation in North Africa and the Near East* (Rome: FAO, 1983).

presided as expected—although Chatterton sniped from the sidelines about its "failure".[181] Nor did the keynote speakers endorse the efforts to directly transfer the SA system to MENA. FAO Assistant Director General, D. Bommer argued that an "understanding of social structures and economic and cultural motivation" was needed to effect such a transfer. Another FAO agronomist with over three decades of experience in the region chastised the commercial orientation of SA projects given the substantial benefits SA had reaped from Mediterranean legumes.[182] He called for fruitful North-South exchanges through technical and financial assistance to benefit the poorest. Oram, who had moved from FAO to the International Food Policy Research Institute was quite critical of efforts to directly transfer the system and recommended much more attention to socio-economic issues. Australian scientists were also more cautious. Doolette who had done so much over a decade to demonstrate the technical feasibility of the system noted the diversity of farms and tenure regimes and recognized a "need for knowledge of farm size, ownership, resources, cropping patterns and attitudes."[183]

Despite these cautionary messages, SADA continued to pursue projects in the region. Negotiations with other countries were started during the Chattertons' 1979 trip, building on what they perceived as the Libyan success. After some initial reticence, these were continued under the succeeding SA government and a state-owned private company, South Australian Agriculture International (SAGRIC Int) was created to efficiently manage the projects outside of government bureaucracy.[184] In 1980 SADA (through SAGRIC Int) signed a US$10 million deal with Iraq to develop a 5,000 ha demonstration farm in the Kurdish area in northern Iraq. This was modeled on the Libyan project and "fencing materials, silos, sheds, the whole box and dice came from Australia."[185] As one SA agronomist recalled "we ran the project as much as we could just as our farmers run it here [in SA]."[186] Beyond design flaws, notably the lack of any outreach or extension component on the Iraqi side, the timing was unlucky. The Iran-Iraq war broke out in 1980 and conflicts between the Iraq government under President Saddam Hussein and Kurdish insurgents meant that a military guard had to accompany the Australian advisers at all times—even in the field. Despite this security, the fences and sheep were frequently stolen and the livestock component was abandoned. Even more tragically, the Iraqi project director was assassinated—a serious blow to the project. Further, as Saddam Hussain's infamy grew on the international stage, SADA was gaining a reputation for associating with Arab despots, following its 1970s project in Libya. The Iraq project ended in 1985 as did a parallel and equally unsuccessful project run by Western Australia in northern Iraq that assessed its impact as "virtually nil."[187]

Another SADA adventure in Algeria beginning in 1979 also failed. Departing from its original mission of building markets for SA products, SAGRIC Int morphed into a consulting firm

---

[181] B. A. Chatterton, "Dryland Congress a failure," *Stock Journal* Sept 11, 1980.
[182] G. Perrin de Brichambaut, "Dryland agriculture in the Mediterranean regions of the world," In *International Congress on Dryland farming. Proceedings* (Adelaide: Dept of Agriculture, 1984),
[183] J. B. Doolette, "The Australian ley farming system in North Africa and the Middle East," In *International Congress on Dryland Farming,* p. 647.
[184] SAGRIC Int was based on earlier efforts to establish an autonomous projects office.
[185] Interview with Peter Barrow on 30 March 2004, in regard to the history of SADA. Accessed online at https://history.pir.sa.gov.au/__data/assets/pdf_file/0006/48597/Barrow_peter_int.pdf.
[186] Interview with Arthur Tideman on 28 Oct. 2003 in regard to the history of SADA. Accessed online at https://history.pir.sa.gov.au/__data/assets/pdf_file/0018/16443/tidemanfin.pdf.
[187] Halse, "Lessons from attempts to transfer farming technologies." p. 317.

employing seconded SADA agronomists and outside consultants. The World Bank had mounted its first agricultural project in Algeria to develop a rangeland region inhabited by nomadic sheep herders. SAGRIC Int signed a substantial contract ($8m) to carry out detailed studies on the region as a basis for subsequent investments. With leadership problems, lack of technical capacity, ignorance of nomadic grazing traditions, and inexperience on both the SA and Algerian sides, the project was seriously delayed and assessed as "marginal at best" by the World Bank.[188] Brian Chatterton inherited these problems when he returned as Minister in 1982 and with his focus on medics, made an unsuccessful attempt to add a pilot ley farming effort in the Algerian cereal zone. The earlier work on medics in the 1970s by CIMMYT and FAO had already disappeared with scarcely a trace.[189]

Finally, SADA managed a conventional development project to introduce ley farming in Jordan from 1980 funded by Australian foreign assistance. This was aimed at small private farmers although model farms were established to conduct adaptive research and demonstrate the technology. Adoption of medics was minimal and mostly by large farms. Vetch for grain and hay was later added as an option and farmers expressed their preference by adopting vetch over medics. [190] Vetch is taller than medics and managed as a crop often mixed with a cereal, factors that, given local tradition, protected it from grazing by outside herds without the need for expensive and controversial fencing. It also provided more flexibility to use for early grazing, cut for green or dry fodder, or harvest for grain.

When the Labor Party resumed power in 1982 and Brian Chatterton resumed his ministerial post, the Chattertons moved aggressively to restructure the projects. However, this resulted in protracted bureaucratic and political infighting, notably a "colossal row" between the Minister and SADA's Director General.[191] The Chattertons were also highly critical of scientists whom they perceived as having vested interest in prolonging their research as well as being out of touch with farming reality. Dunstan an ardent supporter of the overseas ventures in the 1970s was no longer premier and Brian Chatterton claiming lack of political support resigned as minister in 1983 although he and Lynne would continue to be intimately engaged as private citizens in the medic saga for another decade.

Taking stock and phasing out

By the late 1980s after nearly two decades of efforts by CIMMYT, ICARDA, FAO, SADA, JAA, and others to transfer the Australian model and against the early estimate of its potential in the tens of millions of hectares, there were at most 50,000 ha of sown pasture legumes, mainly

---

[188] This was aptly described as the "blind leading the blind." Tideman, *The Medic field*s. World Bank, Project Performance Audit Report: Algeria technical assistance-Rural development project (Loan 1159-AL) (Washington DC: World Bank, 1985).

[189] M. E. H. Maatougui, "Constraints to the ley farming system in Algeria," In *Introducing Ley Farming in the Mediterranean Basin,* In Christiansen et al., *Introducing Ley Farming to the Mediterranean*. A. Abdelguerfi, J. Y. Chapot, & A. P. Conesa, "Contribution à l'étude de la répartition des luzernes annuelles spontanées en Algérie selon certains facteurs du milieu," *Fourrages* 113 (1988): 89-106.

[190] A. El-Turk, "Attempts to introduce the ley farming system in Jordan," In *Introducing Ley Farming.* Tideman, *The Medic Fields.* R. Reeves. *Hot-Spotting: An Australian Delivering Foreign Aid* (Mile End, SA: Wakefield Press, 2007).

[191] Interview with Peter Barrow *op cit.* Full details are in Interview with Jim McColl, *op cit.* Also see "A political conflict hits agriculture in SA." *Stock Journal*, 1983

medics in North Africa.[192] However, the constraints were much better understood, largely through research by ICARDA, which had increasingly integrated livestock, socio-economic, and farming systems research. ICARDA's forage program also diversified under the leadership of SA's Phil Cocks during the 1980s. Alternatives to medics such as vetches were studied, and farm surveys were initiated to describe the diversity of farming systems, quantify the relative importance of cereals (both wheat and barley) and livestock, understand grazing management and seasonal fodder calendars, and even assess the forage value of "weedy" fallows. ICARDA also initiated a concerted effort to work with local farmers using participatory approaches.

The end of the 1980s was another period of stocktaking through a series of conferences the most important being ICARDA's conference, *Introducing ley farming in the Mediterranean Basin,* held in Perugia, Italy, with participants from 15 countries. Building on the much-expanded research base and the experience in many countries, the previous consensus was now more nuanced in recognizing the difficulties of introducing the system. Economists questioned the profitability of ley farming with medics over alternative systems and the high cost of fencing irregular fields, even if fencing could be made socially acceptable.[193] Participants recommended more focus on transferring concepts rather than the system, better socio-economic and geographic targeting, and efforts to improve existing systems based on "weedy fallows." But they also concluded that "notwithstanding outstanding problems, work on ley farming should proceed to an extension phase."[194]

This was a turning point for ICARDA as it began to phase out its work on ley farming seeking more flexible options that considered food as well as forage legumes and harvesting for grain and green and dry fodder, as well as grazing.[195] These options recognized that herders needed flexibility to move the feed to the animals as well as to move their animals to the feed. ICARDA scientists, especially its social scientists, were increasingly vocal in their criticism of ley farming concluding that medics were less profitable to small farmers than traditional systems.[196] In Syria, Tah village, the focus of over a decade of onfarm research efforts, was described in a paper entitled "Another unsuccessful attempt to introduce ley farming in the Mediterranean Basin"[197] France's leading specialist for Mediterranean pastures also chimed in by noting that "hundreds of

---

[192] K.G. Boyce, P. G. Tow, & A. Koocheki, "Comparisons of agriculture in countries with Mediterranean-type climates," In *Dryland Farming: A Systems Approach,* V. Squires & P. Tow (Sydney: Sydney University Press, 1991) pp. 250-60. M. Bounejmate, "Role of legumes in the farming systems of Morocco," In *The Role of Legumes in the Farming Systems of the Mediterranean Areas.* A. E. Osman, M.H. Ibrahim & M.A. Jones, eds, (Dordrecht: Kluwer Academic Pub., 1990).
[193] T. L. Nordblom, "Ley farming in the Mediterranean from an economic point of view," In *Introducing ley farming*
[194] "Discussion and recommendations," In *Introducing Ley Farming,* p. 289-93.
[195] A. El Moneim & J. Ryan, "Forage legumes for dryland agriculture in Central and West Asia and North Africa," In *Challenges and Strategies for Dryland Agriculture,* S. C. Rao & J. Ryan, eds (Madison, WI: American Society of Agronomy, 2004).
[196] T. L. Nordblom, D. J. Pannell, S. Christiansen, N. Nersoyan, and F. Bahhady, "From weed to wealth? Prospects for medic pastures in the Mediterranean farming system of north-west Syria," *Agricultural Economics* 11, 1 (1994): 29-42. J. Tiedeman, B. Boulanouar, S. Christiansen, and M. Derkaoui, "Sheep production on medic and weedy pasture in semi-arid Morocco," *Journal of Range Management* 51, 3 (1998): 288-292.
[197] S. Christiansen, M. Bounejmate, H. Sawmy-Edo, B. Mawlawi, F. Shomo, P. S. Cocks, and T. L. Nordblom, "Tah village project in Syria: another unsuccessful attempt to introduce ley-farming in the Mediterranean basin," *Experimental Agriculture* 36, 2 (2000): 181-193.

millions of dollars have been spent …since the 1960s, with a net result of less than 10,000 hectares of actually ley farming in the Mediterranean basin today!"[198]

Several post-mortems provide excellent reviews of the effort to transfer the ley farming system, many by actors who participated in them.[199] In short there were technical problems such as choice of medic cultivars and depth of ploughing that were largely solved through adaptive research in many of the projects. Others related to weeds and pests not found in Australia, some quite unexpected such as the severe damage to medic pastures by the invasion of tens of thousands of sky larks in Iraq.[200] These pest issues might have been overcome with further research or other measures. More intractable was the effect of economic policies such as subsidies on nitrogen fertilizer and on livestock feeds that biased incentives against ley farming. However, the overwhelming problem was lack of control by farmers over grazing rights of medic pastures due to traditional land tenures. As a long-time ICARDA agronomist noted "with open grazing rights, management of grazing of the pasture phase is impossible." Even on individual fenced farms, grazing management to supply adequate feed and at the same time leave sufficient seed for medic self-regeneration was found to be a "delicate and tricky system" requiring considerable skill.[201] Doolette, who had pioneered the effort in 1970, recalled years later:

> "There would have been better acceptance had we listened to the traditional farming ways and the reasons for these traditions and taken into account the social and political implications."[202]

By the early 1990s with SADA and ICARDA phasing out their work on ley farming, all, including national scientists and extension agencies, were moving on—all except the Chattertons. After their political demise, the Chattertons continued to soldier on through a series of consulting contracts with FAO and others, eventually moving to an olive grove in Italy to facilitate travel within the region. Given their advocacy of strong extension efforts with farmers, they produced a detailed manual on medic pastures and a series of videos and other extension aids.[203] In 1996 they published a book, *Sustainable Dryland Farming,* to explain and promote the huge potential of ley farming based on medics in the region.[204] Rich in historical perspective from SA, the book provides a critical review of Australian projects in the region that laments the lack of farmer involvement, both local and SA farmers. They are especially harsh on Australian professionals, deploring their "absence of intellectual rigour that is reflected in the way in which

[198] H. N. Le Houérou, "Unconventional forage legumes for rehabilitation of arid and semiarid lands in world isoclimatic Mediterranean zones," *Arid Land Research and Management* 15.3 (2001): p. 198.
[199] For succinct reviews see, S. Risopoulos, "The perils of technology transfer: The Australian wheat/medic system in the Near East/North Africa, *Tropicultura* 8, 4 (1990): 196-98. Boyce et al., "Comparisons of agriculture in countries with Mediterranean-type climates." For views of a political scientist, see R. Springborg, "Impediments to the transfer of Australian dry land agricultural technology to the Middle East," *Agriculture, Ecosystems & Environment* 17, 3-4 (1986): 229-25.
[200] N. Halse and H. J. Trevenen, "Damage to medic pastures by skylarks in northwestern Iraq," *J. Applied Ecology* 22(1985): 337-46.
[201] M. H. Halila, A.B.K. Dahmane & H. Seklani, "The role of legumes in the farming systems of Tunisia," In Osman et al., *The Role of Legumes,* p. 113-130.
[202] Tideman, *The Medic Fields*. p. 42.
[203] B. Chatterton, & L. Chatterton, *Fodders for the Near East*: *Annual Medic Pastures* (Rome: FAO, 1989).
[204] L. Chatterton, & B. Chatterton, *Sustainable Dryland Farming: Combining Farmer Innovation and Medic Pasture in a Mediterranean Climate* (Cambridge UK: Cambridge University Press, 1996).

data and experiences are simply ignored or rejected."[205] Yet the Chattertons themselves failed to cite the increasing evidence from the 1980s questioning the relevance of ley farming in the region, notably ICARDA's 1989 conference on ley farming experiences across MENA. As in their earlier writings they did not seriously address the problem of grazing management beyond vague talk of "incentives to maintain pasture" and their faith in transferring the SA farming system model to MENA never wavered.

To be fair, the SA adventures in MENA took place against the backdrop of a highly influential article in *Science* in 1968 by G. Hardin, *The tragedy of the commons.*[206] Hardin had argued that open access to natural resources such as pastures leads to overexploitation and degradation to the detriment of society as a whole. He further proposed that these "market failures" were best remedied through privatization of those resources by granting exclusive property rights to individuals and households, or sometimes by central (i.e., state) control of the resource. Yet over the next two decades, the political scientist and future winner of the Nobel Prize in Economic Sciences, Elinor Ostrom, was assembling case studies to show how many communities voluntarily organize to collectively regulate the use of their common pool resources to the benefit of the community.[207] There is little evidence of successful cooperation among farmers and herders for improved pastures in MENA probably in part due to state appropriation of traditional common property rights in many countries as well as the fact that herders were often nomadic and from different tribal or ethnic groups than farmers. However, in the wake of Ostrom's seminal contributions, ICARDA and others have, in the 21st century, facilitated pilots based on collective action for restoration of pastures in the arid zone.[208]

Meanwhile back in SA, ley farming was also in trouble. In 1981, only one year after the International Dryland Farming Congress in Adelaide, SADA organized a symposium at Roseworthy on *The medic crisis in cereal-livestock farming systems of South Australia.* Ted Carter, who had done so much to promote the system in MENA, listed ten reasons why the system was in decline in SA. These included the lack of investment by farmers in pastures, poor grazing management, increased frequency of cropping, growing damage from insects, increased use of herbicides, and rising acidity in some soils. These problems in turn reflected the system's "reliance on a very narrow suite of legumes and the tendency to manage these as monocultures".[209] They also related to changing economic conditions—declining wool prices relative to wheat had reduced the length of the pasture phase, and introduction of non-legume crops, especially canola, had led to increased use of nitrogen fertilizer.[210] It also seems that the famous Donald "opera house" curve of wheat yields had overestimated the gain in yields from

[205] *Ibid,* p. xx.
[206] G. Hardin, "The tragedy of the commons," *Science* 62 (1968): 1243-8.
[207] E. Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (New York: Cambridge University Press, 1990).
[208] A. Nefzaoui, H. Ketata, & M. El Mourid, "Agricultural technological and institutional innovations for enhanced adaptation to environmental change in North Africa." In S. S. Young and S. E. Silvern, eds. *International Perspectives on Global Environmental Change,* 2012, pp. 57-84. https://www.intechopen.com/books/1011
[209] J. G. Howieson, G. W. O'Hara, and S. J. Carr, "Changing roles for legumes in Mediterranean agriculture: developments from an Australian perspective," *Field Crops Research* 65, no. 2-3 (2000): 111.
[210] J. F. Angus, "Nitrogen supply and demand in Australian agriculture," *Australian Journal of Experimental Agriculture* 41, 3 (2001): 277-288.

ley farming due to the unique weather and price conditions of the 1950s.[211] Indeed, during 1960-90 when SA was promoting its technology in MENA wheat yields in SA rose more slowly than in any country in MENA except Algeria.[212] The biggest benefit of the dryland system in SA was undoubtedly on the livestock side, an area where MENA appear to have made little progress in improving productivity even until today.

The trend to more intensive cropping in SA accelerated during the 1990s after the collapse of the wool market. Integration of crops and livestock through pastures remained a goal, resulting in a search for "second generation legumes", again from the Mediterranean region, to increase biodiversity and adapt to changing economic and environmental conditions. "Phase farming" with several years of crops followed by several years of pastures, and minimum tillage to reduce soil loss were also on the rise.[213] These changes along with the introduction of semi-dwarf wheat varieties from CIMMYT suited to drylands enabled SA to resume an upward trend in wheat yields.

Although change in MENA has been much more diverse across countries and rainfall regimes there has also been important evolution in farming systems there as well. Land left fallow has declined almost everywhere as cropping has become more intensive. Both grain legumes and forage legumes (but not medics) are on the rise, but so is the unsustainable trend toward continuous cereals.[214] Livestock numbers have dramatically increased but supplying adequate feed resources and arresting land degradation and desertification continue to be major challenges.

V. Conclusions

This tour of a century of Mediterranean exchanges built around pastures suggests a number of insights relating to technology transfer and evolution of farming systems, more generally. At first glance, Australian farmers and scientists did develop a dryland farming system integrating crops and livestock that was an "alternative" system to the prevailing trend toward systems dependent on external inputs. However, the motivation for adopting the system was largely economic rather than a strong environmental ethic. Even the need to control soil losses from bare fallow had become an economic necessity in many badly eroded areas. The lack of adoption of this system in other dryland areas, notably MENA, reflected in part different economic incentives and

[211] As noted, rainfall was well above average in the 1950s. The high wool prices in this period also extended the pasture phase of the rotation and shifted marginal land from wheat to wool. See also J.F. Warren, "Wheat yield trends in Australia," *J. Aust. Inst. Agric. Sc.* 35(1969): 240-52.

[212] Computed through linear trend analysis of yields available online at https://www.fao.org/faostat/en/#home. However, absolute yields in SA remained above those of most countries in MENA. For similar conclusions see, A. Hamblin & G. Kyneur, *Trends in Wheat Yields and Soil Fertility in Australia* (Canberra: Aust Gov Publishing Service: 1993).

[213] A. Loi, J. G. Howieson, B. J. Nutt, and S. J. Carr, "A second generation of annual pasture legumes and their potential for inclusion in Mediterranean-type farming systems," *Australian Journal of Experimental Agriculture* 45, 3 (2005): 289-299. T. G. Reeves, and M. A. Ewing, "Is ley farming in Mediterranean zones just a passing phase." In *Proceedings of the XVII international grassland congress* (Wellington, NZ: SIR Publishing, 1993), p. 2169-77.

[214] S. Ates, , D. Feindel, A. El Moneim, and J. Ryan, "Annual forage legumes in dryland agricultural systems of the West Asia and North Africa Regions: research achievements and future perspective," *Grass and Forage Science* 69, no. 1 (2014): 17-31.

endowments of land, labour and capital.[215] Over time, however, incentives have converged with market liberalization so that use of nitrogen fertilizer on cereals has become standard practice in both SA and MENA in all but the driest margins of farming. Further, there has been a global convergence of thinking about the importance of legumes in sustainable farming. The worldwide movement to "conservation agriculture" is defined by FAO by three principles.[216] In addition to minimum soil disturbance, they include maintenance of year-round soil cover and increased diversity of crops in a rotation, both commonly achieved by adding legumes to the farming system.

Second, the scientific community overemphasized the role of "climatic analogues" in the Mediterranean exchange. To be sure there was a strong rationale for Australian scientists to seek forage legumes from the Mediterranean region since as a biological innovation they were quite sensitive to climatic factors—forages that were earlier introduced from the UK were unsuited to the dryland wheat areas. As observed by a leading legume scientist, "Australia is umbilically connected to the Mediterranean region for germplasm."[217] In contrast, the transfer of an entire farming system based on climate analogues was surely naïve, even at the time. After all, Australian pasture science was initially built on the application of concepts and methods from the UK, above all at Aberystwyth, in a very different climate. These strong links built the capacity of Australian scientists to effectively apply these concepts and methods in their own environment. In returning the medics to MENA, scientists initially saw the task as a biological innovation to simply replace fallow with a suitable pasture species, rather than working out how to intensify crop-livestock systems in a very different social and economic context.[218] Indeed, these socio-economic differences far outweighed the climatic similarities.

This history also highlights how in the early post-colonial period, international organizations greatly facilitated interaction across continents and countries with different imperial ancestries and cultures. In the pre-War period, Australian scientists operated largely within the confines of the British imperial scientific establishment. Strong as British science was, it limited interaction of Australian scientists with other major players, including the US that had been collecting annual medics in the Mediterranean and undertaking research that led to their wide adoption from around 1900. This research did not come to the attention of Australian scientists until 1940 by which time, US had largely lost interest in medics as nitrogen fertilizer became widely used. Similarly, Australia was slow to organize collection expeditions to the Mediterranean region. Even after the high potential value of such expeditions had been verified in the field in 1928 it took more than two decades to mount the first organized expedition. Part of this reflected scarcity of resources in the depression and the outbreak of war, but lack of local contacts to arrange logistics was also a significant factor. From the 1950s, FAO, and later the CGIAR centers, assumed a mandate to provide or facilitate the collection and conservation of genetic resources. Although these international bodies were seen as assisting poorer countries, they

---

[215] There appears to be a parallel story on low adoption of forage legumes in tropical Africa. See J. Sumberg, "The logic of fodder legumes in Africa," *Food Policy* 27, 3 (2002): 285-300. Also, see the commentary on Sumberg by J.N. Lenna and D. Wood and the rejoinder.
[216] https://www.fao.org/conservation-agriculture/en/
[217] W. Erskine, Benefits to Australia from involvement in agricultural research for development, using Western Australia as an example. Accessed online at https://www.crawfordfund.org.
[218] Maatougui, "Constraints to the ley farming system".

greatly benefited research on pastures, and on agriculture more generally, in Australia.[219] Similarly, after 1970 FAO and CGIAR played central roles in research and capacity building for "returning the medics" by promoting the ley farming system in MENA.

Third, it required many years of transfer efforts to recognize the limitations of the ley farming system in MENA. This applied not only to the Australian scientists and project managers, but also national leaders, and the international organizations. Initially the narrow disciplinary orientation of research teams resulted in an overly technical approach to the problem. Over time, however, scientists active in the field, both Australian and national, came to appreciate the challenges. Still, they were slow to understand the variation and complexity of existing farming systems and to introduce more flexible options to meet this underlying diversity. Moreover, champions, with high-level political connections, strong communication skills, and a great deal of energy, remained enthusiastic promotors, delaying a change in strategy. This "misguided enthusiasm" in the face of growing evidence of the limitations of the system seemed to reflect a combination of humanitarian motives and a quest for international fame in an era of "brand heroes" in international agriculture, such as Norman Borlaug.[220]

A century of Mediterranean exchange has undoubtedly produced enormous benefits to Australia. This is especially so in acquiring genetic resources, but its scientists and farmers also gained from overseas experience and interaction in returning the medics to MENA.[221] SA agribusiness achieved significant sales although far less than initial expectations. It is more difficult to ascribe benefits to the countries of MENA since the experiences were highly diverse, but it has undoubtedly been much less. Oil rich countries that invested heavily in the projects did not see a return, partly due to difficulties of adapting the system, but also to political and economic instability. However, there were also benefits to countries in appreciating and conserving the richness of their genetic heritage, in building their capacity for research on forages, and in establishing broader scientific linkages outside of their historic ties to Europe. Sustainable intensification of dryland agriculture through the integration of crops and livestock remains a challenge today in MENA and continued interaction with Australia, among others, still has the potential to yield mutual benefits.[222]

---

[219] J. P Brennan, A. Aw-Hassan, K. J. Quade, & T. L. Nordblom, *Impact of ICARDA Research on Australian Agriculture*, Economic Research Report No. 11 (Wagga Wagga: NSW Agriculture. 2002).
[220] Sumberg et al., "Public agronomy"
[221] Erskine, "Benefits to Australia."
[222] In the 2010s, Western Australia renewed ties with Libya to experiment with regeneration of rangelands through collective action by herders to establish "exclosures" sown with pasture species including very early maturing medics. G. Gintzberger, pers. comm.