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THE MUSLIM AGRICULTURAL REVOLUTION AND ITS INFLUENCE ON EUROPE

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Abstract

Since the dawn of civilization the Levant with its varied flora and fauna has provided a rich diet for its indigenous population. This resulted in the area becoming a desirable target for conquest. Amongst the major conquerors were numbered the Greeks and Romans who exploited the area's crops through an essentially tributary economy. The belief that their presence was permanent discouraged introducing new types of crops.

When the Roman Empire finally disintegrated, its tributary economy disappeared, civilization collapsed and all development stagnated. This dismal situation prevailed until the establishment of Islam (7th century C.E.) when the Muslim Agricultural Revolution transformed the essentials of life and its environment. Subsequently Muslim scientists, physicians and botanists set scientific development into motion. Amongst the trailblazing Muslim scientists Ibn Al-Baytar (circa 1188–1248 C.E.) and his like created a phenomenal repertoire in the field of botany. The progress of Muslim scientific knowledge then continued uninterrupted for several centuries.

What happened to the Europeans beyond the Pyrenees? Why did they lapse into a medieval feudal system with no improvement in lifestyle albeit for the well being of the people until the 18th century? How did the change in attitude occur, so that what was once regarded as quackery, folklore and medical heresy became accepted as scientific information? What was the impetus that led the Swedish botanist known as Linnaeus (1707–1778 C.E.) to undertake his compilation of the flora and fauna of the known world? This paper attempts to answer these questions and comments on the relationship between the environment of Ibn Al-Baytar and that of Linnaeus.

The Muslim Contribution to Botany

Medico-botanical books have been produced since the dawn of civilization; records from Egypt, Mesopotamia, China and India reflect a tradition that existed before man discovered writing. Conversely, nothing in the West evidences such antiquity. The first herbal in the Greek language was written in the 3rd century B.C.E. by Diocles of Carystus, followed by Crateuas in the 1st century C.E. The only consistent work that has survived is by Pedanios Dioscorides[1] of Anazarba "De Materia Medica" (65 C.E.). He remains the

[1] The herbal of Apuleius known variously as: De medicaminibus herbarum Liber uno, Herbarius Apulei Platonici- Herbarum de Sextus Apuleius Barbarus, Herbarium Apuleius Plato and De Herbarum virtutibus. This work was plagiarized several times in Classical times but reappeared in the 15th century under new titles. The author is definitely a pagan from North Africa who was a student of Plato's Philosophy and his work included plants and reptiles from the Sahara. My conclusion is that this is the lost work of the King of Numidia Juba II (d.25 C.E.), husband of Cleopatra Selena, who spoke Greek and Latin, worshipped the Goddess Isis and wrote about his travels to the Sahara. F. J. Anderson, An Illustrated History of the Herbals, New York 1997- p.3; p. 24 -The work was given a Christian iconography in the 8-9th cent. It was printed in the

only known authority amongst the Greek and Roman herbalists. The first treatise written on agriculture in the West was just after the fall of Carthage; it was a Roman Encyclopaedic work written by Cato[2] the Elder (234-149 B.C.E.) on medicine and on farming that was called "De Agricultura", the oldest complete Latin prose on this subject.

However, the stability of the world in which these works were compiled came to an end with the disintegration of the Roman Empire. In places where the authority of the empire no longer existed, its haphazard replacement by the early stages of feudalism brought little stability. Conflicts for the possession of the land were liable to break out anywhere. Civilization was near to collapse and all development halted. This dismal situation prevailed until the advent of Islam (7th century C.E.).

In 711 C.E., within a century of the establishment of Islam, the area under Muslim influence had become one of robust economic development capable of yielding the wealth necessary to finance the protection of an area stretching from the foot of the Pyrenees to the frontiers of China. The widespread patronage of intellectual works was a key factor in this development and this resulted in the flowering of Islamic culture and civilization in the Muslim world.

This civilization had such momentum that - despite constant threats of invasion and internal dissension - huge strides were made in agriculture, medicine and science. Hence a wide range of raw materials and the means of adapting them for curing illnesses and for enhanced forms of nutrition became available.

This great movement in agriculture was largely due to central government sponsoring an extensive network of irrigation canals. In the Near East good results were achieved. However, in the West the situation was less promising. The Iberian peninsula subsistence level agro-economy was only rudimentary[3]. In fact it was defined by race. The Visigoth herder overlords jealously protected their stock-rearing interests[4] whilst their conquered subjects produced wheat, barley, grapes, olive oil and a few vegetables, all inherited from their previous Roman masters. Thus the only links between the two systems were those of tribute or taxes.

Once the Muslims had assumed control of the province, there was a need to define which crops to cultivate. Fortunately, the Arab botanical range was already extensive and growing rapidly. In their territorial expansion, the Muslims had come across plants and trees, which were hitherto unknown to them, whilst their merchants brought back exotic plants, seeds and spices from their many voyages. Many of the more

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14th century with examples in Italian, German, French and English. Manuscripts in Laurenziana Archivo della Badia Montecassino cod. 97.- R.W.T. Gunther, The Herbal of Apuleius Barbarus from the early 12th cent. manuscript (MS Bodley 130) Oxford 1925- and W.T. Stearn, E. Caprotti 2 vols, Milan 1979.

[2] Marcus Porcius Cato a Roman political leader who was a fervent enemy of Carthage and constantly sought its destruction. Carthage was a Phoenician enclave in North Africa famous for its agricultural ability and commercial success. It is related that Cato went to the Senate one day and dropped onto the floor a large fig brought from Carthage. It caught the admiration of the senators for its size and he warned them that this land is only 3 days away by sea from them. He constantly repeated "Carthago delenda est" (Carthage must be destroyed) which eventually happened and its soil was ploughed with salt to prevent anything growing again.

[3] a) Clay Stalls " Despite an often harsh ecology, the Ebro River Valley provided pasture for pastoralism under the Roman. In the 5th century C.E.: a decline in population under Visigoth rule". p.4 in Possessing The Land: Aragon's Expansion into Islam's Ebro Frontier under Alfonso the Battler 1104-1134 -E.J. Brill, Leyden 1995. b) Strabo Ist cent. C.E. De Geographia- c) L. Bolens IV op.cit. p.268 " Iberian desert transformed in green pastures". d) Elena Lourie "A Society Organized for War: Medieval Spain"- Past and Present 35 (1966):55.

[4] By means of their Forum Iudicum issued in the VIth and VIIth centuries. Jaime Vicens Vives, An Economic History of Spain - Princeton University Press 1969, p 83-92.

valuable crops such as sugar cane, bananas[5] and cotton needed plenty of water or at least a monsoon season. Thus to cultivate them, a widespread artificial irrigation system would be needed. Artificial irrigation was in fact better known to the Muslims than the crop rotation system of colder European lands where it was felt necessary to leave the land fallow, i.e. to recover, for one year in three or four. However, artificial irrigation implied a need to raise water by several metres to guarantee a constant flow within the system. An ideal device existed for such tasks in the form of the Noria, *Na'ura*,[6] the various forms of which represent a subject that merits its own particular study. Hence the Noria became the basis of sophisticated irrigation systems.[7] The use of Norias spread rapidly to the extent that, in some areas, the water system became state property to ensure equitable distribution.[8] In the Valencia area alone some 8,000 norias were built for the needs of rice plantations.[9]

Correct calculation of levels was essential, a task that the successors of Roman agrimensores with their chains of specific length were ill-equipped to perform. In this, the Muslims had the advantage of the advances they had made in mathematics thus making triangulation possible and hence the accurate measurement of height.[10]

The Muslims did not waste time in haphazard agricultural trials, but achieved maximum output by learning how to identify suitable soils and by mastering grafting techniques for plants and trees. The written works and oral traditions of ancient peoples were painstakingly recorded, whilst exchanges between experts became increasingly frequent, so that in all major towns the libraries were full of learned works on agriculture. Arising as they did from a civilization of travellers, the Muslims combed the known world for knowledge and information, journeying in the harshest of environments - as far afield as the Steppes of Asia and the Pyrenees.[11] In this context the discovery of paper[12] stimulated on the spot detailed recording of their journeys and observations.

This plethora of records and information built up to a level that prompted the compilation of encyclopaedic works.

- *Kitāb nabat* (a treatise on plants) by Abu Hanifa Al-Dinawari (d.282/895 CE)[13]
- *Al filaha nabaţiya* (Nabatean agriculture) by Ibn Wahshiyya (IXth century)
- Al Biruni (973-1048*) Kitāb al şaydana* (Pharmacopoeia) - large pharmaceutical encylopedia

[5] The Arabic word for this fruit is *musa* from Sanskrit *mocha*. In fact *banan* means finger in Arabic. See A. Achaya, Indian Food- A Historical companion - Oxford University Press, New Delhi 1994. p.208.
[6] (i) M. Lombard, The Golden Age of Islam p. 31.(ii) Brunhes, J. l'Irrigation dans la Péninsule ibérique et dans l'Afrique du Nord. Paris, 1902- Also known as *saniya*. A large wheel driven by animal power (or occasionally by human power) which carried a series of large earthenware pots (dawlab) tied to a double loop of rope, so that the pots were let down into the water source and then raised to the top of the wheel's action where their contents were discharged into a feeder gully.
[7] (i) Ibn Al Razzaz Al Jazari The Book of Knowledge of Ingenious Mechanical Devices- Transl. Donald R. Hill- Dordrechts Reidel 1974. (ii) P. Guichard, L'Espagne et la Sicile Musulmanes aux XIè et XIIème Siècles- Presses Universitaires de Lyon 1991. p. 52
[8] Ahmed Al Wansharisi Al Nawazil and Al Mi'yar cf L. Bolens Agronomes andalous du Moyen Age III, p.86.
[9] T.F. Glick "Medieval Irrigation clocks" -pp. 425-427.
[10] On spherical trigonometry Habash al Hasib d.850 C.E.- M.V. Villuendas La Trigonometria Europea en el siglo XI-Estudia de la obra de **Ibn Mu'ad**- Barcelona 1979. b) J.L. Berggren Episodes in the Mathematics of Medieval Islam- Springer-Verlag New York Inc. 1986.
[11] M. Lombard, The Golden Age of Islam pp. 57-59.
[12] M. Lombard Textiles dans le monde musulmans -Fés had more than 400 paper mills. p. 203.
[13] Toufic Fahd, Histoire des Sciences Arabes - sous la Direction de Roshdi Rashed- Editions du Seuil Paris 1997. vol. II p.

- Ali B. Sahl Rabban al Tabari (d. 240/855) *Firdaws al hikma*[14]
- Ibn Baqunesh (Abu Othman Saïd Ben Muhamed) (d.1052 CE)
- Ibn Bassal (Abu Abdullah Muhamed Ibn Ibrahim) (d.1100 CE)[15]

By the 12th century in Al Andalus, botany was converted from its role as a purely descriptive science and achieved the status of an academic science. This century was seen as the golden age of Islamic botany with such great scholars as:

- Abu'l Abbas an Nabati (Ibn Rumiyya) d. 636 AH/1239 CE
- Ibn Baytar (1197-1248 CE)[16], *Tafsir kitāb Diasquridus - Jami' al mufradat al adwiya wal aghdiya*
- Al Ghafiqi (d.1166 CE), author of *"Kitāb jami' al mufradat"* (materia medica) .
- Ibn Al ʿAwwam, 12th century author of *"Kitāb al filaha"* (treatise on agriculture)[17]
- Ibn Bajja (d. 1138 C.E.), *Kitāb al nabat* Liber de plantis (Latin transl.), defining sex of plants.
- Najib Eddin as Samarqandi (d.1222 C.E.) wrote a treatise on medical formulary.

The scholars themselves conducted their experiments and taught everywhere, including mosques and weekly markets. This is confirmed by the fact that Ibn Baytar's work was recorded in Arabic, Berber, Greek and Latin whilst Al Biruni's Pharmacopoeia gives synonyms for drugs in Syriac, Persian, Greek, Baluchi, Afghan, Kurdish and Indian dialects etc… Their linguistic capabilities demonstrated their intention of spreading knowledge amongst all nations, as was the case with the distribution of the agricultural Calendar of Cordoba in the 10th century.[18] The Calendar of Cordoba is an example of the type of information provided as an aid to agriculture.

In the aftermath of the Roman Empire conquerors, such as the Visigoths, installed regimes in which the monarch, the nobility and the church fathers owned the bulk of the land, the burghers, who were in charge of municipal affairs, had less than 25 acres each, whilst the serfs were the cultivators and were yoked to the land and were sold with it.[19] The attitude of Muslims was different since they understood that real incentives were needed if productivity were to reach levels that might significantly increase wealth and thereby enhance tax revenues.[20] The Muslims brought revolutionary social transformation through changed ownership of land. Any individual had the right to buy, sell, mortgage, inherit the land and farm it or have it

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[14] Author of an encyclopedia *Firdaws al hikma* (Paradise of wisdom) that covers subjects such as philosophy, medicine, hygiene, botany, astronomy/cosmology. Ibid. p. 77.

[15] Ibn Bassal: libro de Agricultura- Edited by J. M. Millas Vallicrosa and M. Aziman, Tetuan 1955.

[16] Ibn Baytar lists more than 150 authors and 1,400 drugs of which 400 were unknown to the Greeks. Ibid p. 79.

[17] *Kitāb al Filaha* Libro de agricultura, el doctor excelente Abu zacaria Iahia Aben Ahmed Ebn El Awam, Sevillano. Tranlsation Don Josef Antonio Banqueri –Imprenta Real, Madrid 1802.

[18] Calendar of Cordoba *Kitāb al Anwa'* Liber Anoe is an event calendar for the farmer's year. A scholarly work intended to convey a variety of information, including constellation diagrams, on monthly tasks related to soil, plants, animals, seeding, planting and grafting seasons, giving the date for each of such tasks. Three copies were translated into Latin by Abul Hassan 'Arib Ibn Saad Al Katib for Al Hakam II (350-366/961-976 C.E.): one copy was sent to the German Emperor Othon, the second to Constantinople and the third to Jerusalem. Translation R .Dozy, E.J.Brill. Leyden 1961.

[19] a) S.M.Imamuddin, Some Aspects of the Socio-Economic and Cultural History of Muslim Spain- 711-1492- p.10. b) Roland Broadhurst (translator) The Travels of Ibn Jubayr Goodword Books New Delhi 2001-cf pp. 336-340.

[20] (i) Abu Yusuf (731-798 AD.) Taxation in Islam Abu Yusuf's *Kitāb Kharaj* - Ed. And Transl. A. Ben Shemesh. Leyden/London 1969. (ii) Al Dawudi, Abu Ishaq Ja far Ibn Nasr (d. 1011) -Le Règime foncier en Sicile au Moyen Age (ixè et xème siècles). Ed. and transl. by H.H. Abdul Wahhab and F. Dachraoui in 'Etudes d'orientalisme dèdiées à la mèmoire de Lèvi-Provençal'- 2 vols -Paris 1962.

farmed according to his preferences[21]. Furthermore every important transaction concerning agriculture, industry, commerce and employment of a servant involved the signing of a contract of which a copy was kept by each side.[22]

The second incentive principle that was gradually adopted was that those, who physically worked the land, should receive a reasonable proportion of the fruits of their labour.[23] Detailed records of contracts between landlords and cultivators have survived[24] with the landlord retaining anything up to one half.[25]

Thus with all the enhancements and incentives already mentioned, the stage was now set for agricultural development on a scale hitherto unknown. The motivations that prompted phases of agricultural development were of two kinds:

- Political, namely conscious decisions by the central authority to develop under-exploited lands.[26]
- Market-driven, invariably involving the introduction, by means of free seeds, advice and education and by the introduction of high value crops or animals to areas where they were previously unknown.

Consequently, crops and livestock were introduced initially for subsistence purposes, leading to a level of economic security that ensured wealth for all. The quality of life was enhanced[27] by the introduction of artichokes, spinach, aubergines, carrots, sugar cane and various exotic plants. Vegetables were available all year round, obviating the need to dry them for winter. Citrus and olive plantations became a common sight,[28] whilst market gardens and *jananat* (orchards) sprang up around every city.[29] All this involved intense cropping and imposing heavy demands on land fertility[30] but the technique of intensive irrigation agriculture with land fertility replacement had now been mastered.[31] In the field of development for economic ends, animal husbandry was of prime importance for its manure in addition to its meat. The latter was now plentiful in places where in the past it had been a luxury. The fine quality of the wool of the Maghreb soon became known throughout the world.[32] Selective breeding using animals from different parts

[21] A. M.Watson. Agricultural innovation in the early Islamic world. London 1975. p.113.
[22] *Al Maqsad al mahmud fi talkhis al 'uqud* by Abul Hasan Ali Ibn Yahya Ibn Qasim al Sinhaji of Algeciras (d.585/1189).
[23] Abd el Wahid al-Fihri and Ahmad al-Tulaytuli (both law scholars of the early XIth century).
[24] Islamic law stipulates that the sharecropper is entitled to one fifth, (*Khomos*, hence khamās/*Khamsa* in North Africa for sharecropper). [adapted by Spanish "exarico" ('x' is 'sh' in Spanish phonetics..) b) Clay Stalls op.cit. p.xii
[25] S.M.Imamuddin. op. cit. p.72.
[26] M.Lombard, Les Textiles dans le Monde Musulman...la prolifération des centres techniques depuis l'Est vers l'Ouest du califat, de la partie la plus avancée vers la partie à peine éveillée." p.12.
[27] El Bekri Description de l'Afrique Septentrionale- Trans. Mc Guckin de Slane –Librairie Paul Geuthner Paris 1913. pp.181-323.
[28] M. Lombard,. L'Islam dans sa première grandeur- p.186.
[29] (i) Ibid p.185. (ii) A.M. Watson op. cit "Small undertakings around cities, which were almost everywhere given over to market gardens and orchards "- p. 114 and p. 197 n°12.
[30] As heavy cropping exhausted the soil of its fertility various type of fertilisers were used such as dung of cows, goats, horses, pigeons as well as bones, blood and vegetables. See (i) E. Beazley and M. Harverson op. cit. pp. 103-116.(ii) A.M. Watson op. cit. p. 125 and p. 203. (iii) Ibn Al Awwam Libro de Agricultura -Ed. J. A. Banqueri 2 vols, Madrid 1802. pp 4495-449. (iv) Abu al Khair *Kitāb al Filaha* Ms 4764 Bibliothèque Nationale Paris.
[31] The level of success can be measured by the comments of Al Hymiari, (d.1177), writing in the 12th century, who compared *Al Andalus* to Syria in its fertility, to Yemen for its even climate, to India for its aromatic plants, to China for its mineral riches and to Aden for its seashore economy. See T. Glick op. cit p. 55. Al Ansari writing about North Africa in 1400 AD. He noticed that there were 65 kinds of grapes, 36 kinds of pears, 28 kinds of figs, 16 kinds of apricot etc.- Watson op. cit p.1.
[32] Lombard, Les Textiles dans le Monde Musulman -pp. 22-23.

of the known world resulted in significant improvements in horse stocks and provided the Saharan caravans with the best load-carrying camels.[33]

By contrast, the African countries, instead of relying on the products of their flocks for food, were now able to eat a more balanced diet that included a variety of fruits and vegetables whilst the introduction of cotton and indigo gave them a useful cash crop.[34] Improvements in irrigation made it possible to cultivate this high value plant in the sub-Saharan countries where other dye-making plants were also introduced. In a world that had previously known only flax and wool as textiles, silk and cotton production spread rapidly.[35] Cotton, originally from India, became a major crop in Europe (Sicily and al Andalus) and the overall result was a democratisation of what had been rare luxury goods in the past. Within a relatively short period, mankind could use a wider range of textiles for his clothing which were available in a greater variety of colours. Sugar cane,[36] of Indian origin, was known in the 6th century at the Sassanid court. Because of the endeavours of botanists and agronomists, it spread to Egypt, Syria, Morocco, al Andalus and Sicily.[37]

Thus, within barely a century of the Muslim conquest, the landscape[38] in the area under Muslim control had changed so radically that it is fair to describe the process of transformation as the Muslim Agricultural Revolution.[39] The elements of the success of this revolution can be summarised as:

a. The extension of the exploitable land area by irrigation.

b. The rapid implementation of improved farming techniques derived from the collection and collation of relevant information throughout the whole of the known world.

c. Incentives based upon the two principles of the recognition of private ownership and the rewarding of cultivators with a harvest share commensurate with their efforts.

d. Advanced scientific techniques allowing people like Ibn Baytar to challenge the elements by growing plants, thousands of miles from their origins that could never have been imagined to grow in a semi-arid or arid climate. The introduction and acclimatization of new crops and breeds and strains of livestock into areas where they were previously unknown.

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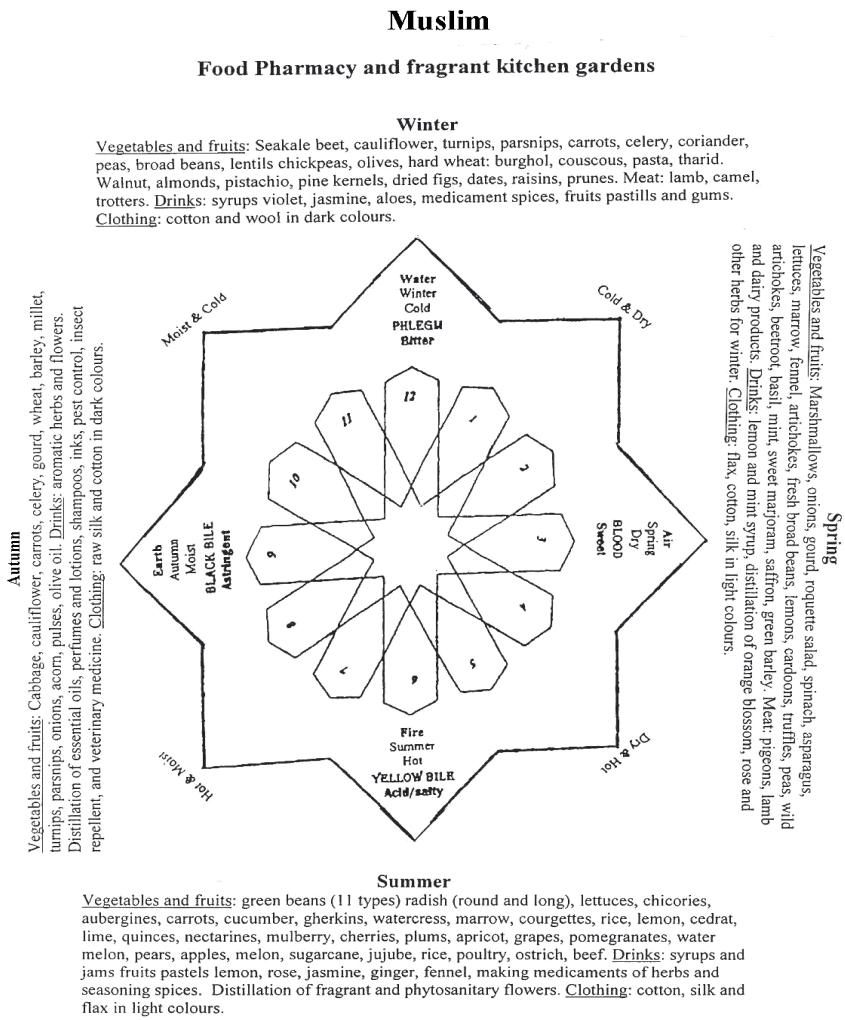
[33] Lombard, L'Islam dans sa première grandeur. p. 187/188.
[34] Ibn Hawqal mentions that the value of indigo stocks held annually in Kabul was two million dinars. Kano was also an important indigo and cotton centre in Nigeria. Ibn Hawqal in Lombard Les Textiles dans le Monde musulman- p. 141.
[35] Al qazaz = the silkworm breeder. The best silk was produced in Al Andalus. Maqdisi. p.239. Lombard Les Textiles dans le Monde Musulman- p.28.
[36] Sugar was known in pre-Islamic time but only to the rich. The Sassanid court imported it from India, therefore the Arabic vocabulary regarding different types of sugar and its refining derives from Persian. For example *phanita* : thickened juice *fanid* in Arabic.(i) Watson op. cit. pp. 26-30. (ii) M. Lombard The Golden Age of Islam p. 25.
[37] Lombard, L'Islam-.p.185.
[38] Ibn Hawqal visited Sicily in 362-363/972-973 and a variety of products being planted there : saffron, cotton, hemp and garden produce. Al Idrisi saw the abundant silk production available. Toufic Fahd Histoire des Sciences Arabes p. 80.
[39] Unfortunately, the "reconquista" reversed several features of this Agricultural Revolution. Several of the new crops disappeared and were only re-introduced many years later, for example: bananas, sugar cane, cotton, artichokes and aubergines. Furthermore, the land fell into the hands of nobles and the ecclesiastical authorities, who used most of it for the production of cereals. Watson op. cit. pp.184-185. cf. Dr Z.S.Aylwin thesis. School of Oriental and African and Studies London 1999.

Another feature of the growth of the Muslim domain was the increase in urbanization that was facilitated by scientific improvements in the fields of hygiene and sanitation. The farmer for his part benefited from the advances made in astronomy.

The measurement of time and of the onset of the seasons and even the prediction of weather became more precise and reliable, as the farmer became informed of the solar movement through each zodiacal sign. He also profited from the compilation of calendars[40] that told him when to plant each type of crop, when to graft trees, when and with what to fertilize his crops and when to harvest the fruits of his labours.[41] Whereas in the past he had lived in a world where he rose and lay down with the sun and relied upon changes in weather to tell him when the seasons might be due, he now lived in a world where his decisions were much easier to make. It now became feasible to think in terms of growing each of his crops for a specific market at a specific time of the year.



[40] a) Gerrit Bos and C. Burnett Scientific Weather Forecasting in the Middle Ages: the writings of Al Kindi- Kegan Paul International, London and New York 2000 - b) *Risala fi Awqat al-Sana* Un calendario anónimo andalusí. Maria Ángeles Navarro. Consejo superior de investigaciones scientíficas. Granada 1990.

[41] Ibn Bassal: libro de Agricultura op. cit. On preparing land before the planting season. p. 61. Information for the farmer and how to recognise the different types of water pp. 183-182.

Furthermore, the same calendar that aided the farmer in his activities also carried recommendations about what to eat and what to avoid at each time of the year. This in turn facilitated the farmer's task of deciding what to plant in relation to future demand.

Medieval Europe

Books on herbals were rare and were known only amongst a small number of scholars who were either financed by the rich or belonged to the church.

Until the end of the 15th century, the "materia medica" was for Europeans the Arabic version of Greek texts translated into Latin. Thus between 1500 and 1600 there were about 78 editions of Dioscorides. The success of the traditionalist Humanists was measured by what they borrowed from Muslim botanists and how they participated in making Dioscorides more prominent. Their interest in Dioscorides during the 16th century Renaissance and their slogan of going back to Greek authors caused the Salerno school to decline even though it was an established centre for Arabic medical translation. Nevertheless its failure was also due to inadequacies in correct herbal recognition and lack of proficiency in the Arabic language. More than 142 composita of Arabic "materia medica" were disseminated in different Salernitan treatises.

The main problem was the language of communication. Only a few could read and write in Latin. They did not understand the Greek texts as most of the time they were second-hand translations. Herbalists were frustrated by ignorance, malpractice, faults in earlier bad Greek translations and also by an inability to identify correctly ingredients in proper vernacular languages. This situation did little to promote either medicine or science.

Thus, Bartholomi Maranta (1559 C.E.) writes to Aldrovandi describing how he recognised a plant described in Dioscorides. Petrus Pena (d. 1605C.E.) and Matthias de l'Obel (d. 1616 C.E.) decided to go as far as Marseilles for their search of Dioscorides plants, but to their disappointment, they concluded that Dioscorides referred to plants that were growing in the Near East and not in Europe.

Therefore the time wasted during several centuries of neglecting Muslim agriculture led Sir Thomas Elyot (1490-1546 C.E.) to inform his readers that he derived no understanding from the ancients, i.e. "*no little profyte concernynge myne owne helthe*".

The only original work written by an Englishman during the Middle Ages was *Proprietatibus Rerum* by a theologian, Bartholomeus Anglicus in the 13th century. He lived in France and this book was translated from Latin into English in 1398. It is full of allusions to Classical writers on herbs such as Aristotle, Dioscorides and Galen without any reference to gardening or experimenting with plants. Also his book proves that he had no practical knowledge of his subject. But surprisingly, this work had 17 editions and was used until the 16th century.

In the Herbarium of Apuleus only 185 plants are mentioned. The Herbarius of 1484, the earliest herbal printed in Germany has only 150 plants recorded. Nobody knows what was growing in their gardens which were referred to as 'wyrtzerd' (lit. Herb yard). The oldest illustrated herbal in Latin, the Herbarium dates from the 5th century CE by Apuleius Planicus, possibly the supposed lost work of Juba II, printed in Rome

after 1480 by John Philippus de Lignamine, physician to Pope Sixtus IV. The school of Salerno was supposed to be a survival of Greek medicine but Bologna was the earliest in Europe that had botanic gardens and it was founded by Luca Ghini.

Pierandrea Mattioli (1501-1577), Italian herbalist and physician to the Archduke Ferdinand and to the Emperor Maximilian II with Fabio Colonna 1592 were the most important herbalists of their day in Italy.

Most of the 16th and 17th century herbals appear to have more than herbs in their contents. In the 1529 work by Sir John Treffy in "Grete herbal" he writes about using mummies' blood and brain in his treatments: "*that mommye is to be chosen that is bright blacke stynkynge and styffe*". Also bathing was regarded as dangerous "*many folke that hath bathed them in colde water have dyed.*" Again in a book of recipes in the Fairfax stillroom by Rodolphus Goclerius, professor of Phisick in Wittenburghte: "*take of the moss of a strangled man two ounces, of the mummia of man's blood one ounce and a halfe of earth-worms washed in water or wine etc*". The plant lore was used by princes and peasants alike. Simple herbs were gathered to cure physical and mental ills but also they collected "mysterious herbs" to guard them, in their primitive imagination, against unseen monsters, elves and giants.

An English physician, Wyllyam Turner (d. 1568) was known as the father of botany. He studied in Italy, visited Germany and Holland and had a garden at Kew. He dedicated his work to Queen Elizabeth I and he says to her,

> *"How many surgianes and aphothcaries are there in England which can understand Plini in Latin or Galen and Dioscorides? - English physicians rely on apothecaries and they in turn on the old wives who gather the herbs. Dyd Dioscorides and Galen give occasion for every old wife to take in hand the practise of Phisick? Dyd they give any inst occasion of murther?"*

He was critical of foreign herbalists too. Although he learnt from them (referring to herbalists in Germany and Italy: Matthiolus, Fuchsius, Tagrus and Dodoneus), "*either knew not al or ellis erred in them (herbs) greatlye*". He also believes that "*if people took a pece of citron are unhurt by the poison of the snakes*". In a similar manner we see the French physician, Symphorien Champier (1472-1539 C.E.) stating that he purposely wrote his prologue in vernacular French since ignorance of Latin by apothecaries as well as surgeons had led to irresponsible actions.

The last of the Great English Herbalists was John Parkinson (d. 1650), apothecary to James I. He wrote two books, *Paradisus* and *Theatrum Botanicum*. The most interesting feature about his work is the description of the "*vegetable lamb growing on stalk and when fully ripe burst open and disclosed a little lamb perfect in every way. The pulp or meat underneath is like the flesh of a lobster. It hath foure legges also hanging down. The wolves much affect to feed on them.*" This myth, deriving from the Greek description of the cotton plant by Herodotus, Pliny and others, carried on throughout the Middle Ages.

Parkinson talks about gardens being joyous now with the introduction of new plants: daffodils, hyacinths, and gladioli from Turkey and Spain. He also mentions that he received from abroad Jasmin, cherries, peaches and he says "*sadly these trees never beare any fruite and therefore are more fit for a garden of flowers than an orchard of fruite*". There is no mention of fertilizers or feed for the plants and he is somebody, who still believes in evil sprits. In his dedication to the king, he writes "*most properly doth this*

worke belong to your majesty's patronage both to further and defend malevolent spirits should not dare to cast forth their venom". Parkinson, on the other hand, seems to be the only one who was concerned about beauty recipes, commenting that they are highly prized: "*distilled water used by French and Italian women.*" He recommends cumin seeds and bishops weed for slimming down. -

The herbal book by Anthonye Askham, "phisycyon" during the reign of Charles II in 1660-1685, included an interesting,

> *"oyle of roses is made thus. Some boyle rose in oyle and kepe it, some do fyll a glasse with roses and oyle and they boyle it in a cauldron full of water and this oyle is good. Some stampe fresh roses with oyle and they put it in a vessel of glasse and set it in the sune iiii dais and this oyle is good."*

Similarly "*oyle of vyolettes is made thus. Sethe vyolettes in oyle and streyne it. It will be oyle of vyolettes*" This shows that he had no idea whatsoever of the distillation process.

Guy de la Brosse, the king of France's physician, wrote a book on medicine without plants "*De la nature, vertu et utilité des plantes. Chasque Chose a son ciel et ses astres*."

France and Germany outlawed imported indigo in the 1500s to protect the local woad[42] industry. Dyes were made using the woad plant and fixed with urine instead of chemicals. People were still washing their clothes with female fern instead of soap.

The above authors are the physicians, apothecaries and botanist of royalty and nobility. Their books remained in the private libraries of palaces and country houses. The rest of the population were victims to the kind of the 17th century charlatan like Nicholas Culpeper. Astrologer and presumed herbalist his book entitled "English Physician Enlarged" in 1698 was still reprinted as late at 1809. He related herbs to stars.

Sir John Hill in 1755 wrote "*The Family Herbal, Virtues of Vegetables of other countries making jams and syrup*". This was the first work addressed to the public at large, which also gave culinary recipes.

Directly or indirectly, medieval herbals relied much on classical sources. The Europeans did not study plants or experiment with them; it was "plant qua pharmacum" i.e. a drug. When they couldn't understand or decipher Muslim drugs they returned to Dioscorides thinking that it had been the original source for Muslim herbalists. In fact, several editions were made in different languages.

Ingredients were assessed on their trade value, like pepper, or for medical usage but not for their nutritional use. The medieval European treatises were based on arithmetical magic, astrology and the doctrine of signatures or a need to balance excesses.

The humanist's struggle to return to the original Greek texts resulted in worsening their medical and botanical information. They were receiving Muslim texts in which the Arabic terms were badly translated. But translators of Arabic were rarer than Greco-Latin scholars in the Middle Ages and their knowledge of

[42] Woad A nauseating plant (Isatis tinctoria), used instead of indigo. The blue dye is obtained from the leaves of this yellow-flowered plant..

the Greek language was imperfect and their botanical knowledge was restricted to the knowledge of plant names.

Plurality of synonyms attached to some plants by Dioscorides, Apuleius or other Greek authors added further opportunities for error. Returning to Greek authors did not solve their problem as Dioscorides was not thorough and lacked the detail that Muslim scholars used in their pharmacopoeia. The breakdown of Latin into local dialects that became the Romance (French/Spanish) and influenced Germanic language families (Flemish/English) brought more errors and confusion to the communication of botanical data and plant names.

In addition, there was no empirical study of plants themselves. They spent their time copying and abridging older codices. The flora described by Greco-Roman authors was essentially Southern in its composition. Thus it was species peculiar to the Mediterranean Basin and Near East that were described in classical texts. Much time and effort was exerted in the futile search for a classical plant name in a Western or Northern European species not known to the ancients. The only contact they had with the plants of classical authors was by literary references and, unless a plant had a classical pedigree, it was ignored. There were no incentives in the Middle Ages to promote public studies of plants; the rich or church scholars being the exception.

Botanists were lacking information on fertilizers, grafting plants or even defining the right place for a plant. Furthermore vegetables were considered peasant food and were eaten sparingly. The root vegetables grown in winter were regarded as animal fodder. It was all right for the populo minuto to live on such fare. Rich people did not contemplate eating vegetables, the higher social classes favoured an excessive amount of meat to show their wealth and status since meat was expensive and also difficult to keep. Even fruit was sometimes considered to cause fevers and other ailments. As a result gout, mineral and vitamin deficiencies were prevalent amongst the upper classes in Europe especially in the winter months. Meat was accompanied by sauces to mask its taste, especially since refrigerators had not yet been invented. Hence French cuisine today has several hundred types of sauces deriving from the ignorance of vegetables in the Middle Ages.

The vegetables in Europe that were obtainable in the Middle Ages were leeks, root vegetables, and cereals: wheat, barley and rye. Occasionally meat (including blood) was available as the rural poor rarely saw fresh meat except for the animals they had to slaughter as winter fodder was scare. Until the 18th century few households in the Northern countries had enough land to grow hay for winter fodder. Peas and beans were dried or powdered to eat in winter such as with soup 'pease pottage' which was still the English national dish (17th century). White fish was reserved for the rich but some people dried fish because crippling taxes on salt and sugar prevented them from preserving meat. The norm in Europe was baked beans, turnips and preserved cabbage. The latter was cut and fermented as valuable food for winter. This, for the French, meant bean 'cassoulet' and for the Germans, cabbage 'sauerkraut'. Preserving oak leaves, roots and fruit berries through fermentation produced the basic kind of food people had. In Russia this was rye bread and pickled cucumbers with oak and cherry leaves. Boiled and preserved cabbage was one of the mainstays of the North European peasant diet.

European royalty and the nobility were, on the other hand, very extravagant in the food they consumed. It was something to display at the baroque banquets held to impress people of great importance and to

dominate the people. With no kitchen garden or access to herbs, people in towns lived on rye bread, pickled root vegetables, salted herrings and cheese with the occasional cheap cuts of fresh meat such as sheep's head or pig's trotters. As a result, scorbutic illnesses were prevalent not only on the seas but also in towns particularly in Northern Europe. It was not until 1753 that the Scottish naval surgeon James Lind proved by experiment that eating citrus fruit cured scurvy, yet it was not until 1795 that the British Admiralty issued an order requiring all members of the Royal Navy to take a daily ration of lemon/lime juice. The forty years delay cost the deaths of 200 000 British sailors by scurvy.

The confusion referred to above, regarding the identity and therapeutic uses of plants became even greater as products from the Indies started to enter the European markets by the 16th century. Thus when new products started to be circulated people did not know whether they were really new ones or old ones already described by the ancient authors '*heard of but never seen*'. Hence Nicholas Monardes wrote in 1574 "*Libro que trata de todas las cosas que traen de nuestras Indias Occidentales*." This work, because of its geopolitical importance, was translated into Latin, Italian (1576), Flemish (1600), French (1619) and into German (1895). Similarly the French interest became evident when Père L. Feuillée, the king of France's herbalist wrote a book on "*American Plants Dyeing wood Gums and Trees*" in 1715 which was immediately translated into English by James Petiver. States started to focus on the problem and decided to give serious attention to the chaos that was about to happen as serious attention was being given to plants that could be exploited on an industrial scale. Field trips and botanising excursions began to be undertaken.

For the European botanists progress had been inhibited by three factors:

1. The language of science, which was Arabic, was lost. No one had any command of it.[43]

2. The botanists had little proficiency in Greek or Latin. Translations of Apuleus were also a basis for the European botanists and they were plagiarising each other's work from the 8th to the 16th century. They were unaware that their own region produced different species. The Greek myths, superstitions and tales that were accepted in Antiquity were repeated in the Medieval period.

3. Their vernacular languages were not sophisticated enough to allow them to correctly identify or describe ingredients.

The World of Linnaeus

Carl Ingemarsson Linn (1771-1778 C.E.), a Swedish born naturalist, was the son of a pastor. He studied medicine at Uppsala University in Sweden and also in the Netherlands. In 1758 his work helped to establish and standardize the accepted nomenclature for species of plants and animals. Western countries have accordingly accepted his Systema Naturae as the official starting point for zoological nomenclature. All names existing before then have no validity unless adopted by Linnaeus (his Latinised name as used by English speakers) and later authors.

[43] The Arabic language was banned in Spain from 1492, for Garcia Ballester, L. Giron F. "el problema politico-religioso derivado de la presencia en Espana de una poblacion morisca". Even if " el arabismo como via de acceso a las fuentes medicas griegas" cad. Hist. Med. Esp., 13, 218-232 (1974). The Arabic language only returned to Spain via France in the 18th century.

He used classical authorities for species' names. He was fond of classical authors and Greco-Roman literature such as the works of Virgil, Ovid and Horace. Thus myth and history were combined to name plants. Heliconii, papilio Priamus, P. Hector, P. Agamemnon after Homeric heroes and military ranks Pan Suecus, Pandora Insectorum, Hesperides, Siren lacertian, reminding the reader of the classical world or by using references from the Christian Bible.

In his contribution as a botanical 'systematist' he introduced order to plant classification in Europe through a binominal nomenclature by which a plant could be identified with just two names. In 1735 he travelled to the continent to finish his medical studies and he obtained his doctorate in medicine after only a week in the Netherlands (Leiden). In 1737 he was engaged as garden director to the banker Georg Cliffort at Hartekamp. In three years he wrote eight books on the single system of classification. Afterwards he visited Paris, London and Oxford before returning to Sweden never to leave there again.

In 1761 he was granted nobility and became Carl von Linné. He occupied a central position amongst botanists in the 18th century. He created classification consistency and precision out of the European herbal chaos. Linnaeus concentrated on classification and taxonomy. He had contact with the new economic thinking of the business and political world especially as the Netherlands and Sweden had interests in their respective East India Companies. He was called upon to send some of his students on Swedish vessels to collect specimens and drawings from India and China.

His work was valued because it came at an appropriate moment when a quantity of new plants and products had accumulated in Europe because of trading in the East Indies. The East India Company, established during the reign of Queen Elizabeth I of England in 1599, was the most unique organization in British colonial history. It was formed by a group of London merchants and was granted a charter authorizing it to trade with the East. Other East India Companies were formed in Europe such as the Dutch East India Company (VOC), founded in 1602, traded with India and Sumatra before the British. The first profit made by the EIC was from the sale of pepper acquired from Sumatran and Javanese trading ports. In 1689 the EIC made a declaration of being the territorial power in India lasting until 1708. The French became involved in 1700. The eighteenth-century was an important period for the East India Company's history in trading with India and China. The trade had been a monopoly of Spain and Portugal until the defeat of the Spanish Armada in 1588. The Danish and Swedish East India Companies imported more tea than the British EIC and smuggled 90% of it to England. As a result the competition was so fierce between European countries that all the powers involved were interested in plant research and investigating methods of culture. However after the Napoleonic wars, British control of the seas spelled the end of the other Europeans' involvement.

After Linnaeus's death, the British founded a botanical Society in his name in 1788, since the national floras of Europe and those of distant lands were becoming better known through colonial power, foreign trade and scientific expeditions. For the first time botanical gardens in Holland, England and France (the three major commercial rivals) were filled with exotic seeds, roots and bulbs. However, Linnaeus would not have been accepted as a botanical legislator if it were not for his use of Greco-Roman literature. Within the framework of the conservative literary European tradition he gave directions for nomenclature in Latin. Linnaeus did not invent anything nor did he add any new discovery; his work was based on previous literature mainly derived from Muslim sources. He merely solved the problem of classification for the West.

He stood outside experimental research of his time and it may be questioned whether Linnaeus ever really made it clear to himself what was actually meant by the term experiment. His work was seen by some as antiquated and primitive and he was accused of delaying the development of modern biology.

Conclusion

In conclusion, in the Muslim culture food was regarded as having pharmacological properties that prevent illness and promote health. Eating a variety of grains and vegetables causes the body to be infused with continual doses of pharmacologically active compounds that act as natural medicines to keep the body strong and less prone to certain diseases. The Calendar of Cordoba is an example of the goodwill and desire to disseminate knowledge during the golden age of the Muslim civilization. Despite the fact that they conquered areas in Spain and Sicily, where all this valuable medical and agricultural information was available, the rulers of the West failed to profit from it. Thus, by ignoring what was available they delayed their medical development by several centuries, whilst keeping their unfortunate subjects deprived of a decent quality of life. This is why it took until the 18th century for the West to achieve a reliable method of cataloguing plants and other organisms that might be comparable with the work of Ibn Baytar that was compiled five centuries earlier.

Bibliography

Achaya, A. Indian Food- A historical companion- Oxford University Press New Delhi 1994.

Al Khattabi, M.A. Atteb wa al atibba fi al Andalus al Islamia Dar Al Gharb al Islami 1988 2vols.

Al Khattabi, M.A. *Umdat al Tabib fi ma'rifat al nabat* by Abul Khayr of Seville Dar al Gharb Islami Beyrouth 1995.

Anderson F.J. An Illustrated History of the Herbals (New York 1977).

Basing Patricia Trades and Crafts Medieval Manuscripts - British Library London 1990.

Berggren, J.L. Episodes in the Mathematics of Medieval Islam- Springer-Verlag New York 1986.

Bolens, L. Agronomes andalous du Moyen Age- Librairie Droz Genève 1981.

Broadhurst Roland The Travels of Ibn Jubayr Goodword Books New Delhi 2001.

Brunhes, J. l'Irrigation dans la Péninsule Ibérique dans l'Afrique du Nord- Paris 1902.

Clay Stalls Possessing The Land: Aragon's expansion into Islam's Ebro Frontier under the Alfonso the Battler 1104-1134. EJ Brill Leyden 1995.

Gerrit Bos and C. Burnett Scientific Weather Forecasting in the Middle Ages: The Writings of Al Kindi- Kegan Paul Intt\. London 2000.

Hill, Donald Hill R. The Book of Knowledge of Ingenious Mechanical Devices- Trans. Of Ibn Al Razzaz Al Jazari Dordrechts Reidel 1974.

Ibrahim Ben Mrad, Tafsir Kitab Diasquridus by Abu Abdellah Ibn Al Baytar (d.646/1248) Dar al Gharb Islami Beyrouth 1990.

Imamuddin, S.M. Some Aspects of the Socio-Economic and Cultural History of Muslim Spain :711-1492- E.J. Brill Leyden 1965.

Jaime Vicens Vives An Economic History of Spain- Princeton Unv. 1969

Lombard, M. The Golden Age of Islam Flammarion Paris 1971.

Navarro, Maria Angeles, *Resale if Awaqat al Sana*- Consejo Superior de Investigacions Scientificas Granada 1990.

Pelner Cosman, Madeleine, Fabulous Feasts Medieval Cookery and Ceremony G. Braziller New York Inc. 1976.

Prieto-Moreno, Francisco Los Jardines de Granada Ed. Ciguena Madrid 1952.

Roshdi Rashid Histoire des Sciences arabes Seuil Paris 1997 3 vols.

Sinclair Rohde, Eleanour The Old English Herbals- Dover Pub. New York 1971.

Stannard, Jerry Herbs and Herbalism in the Middle Ages and Renaissance, Ed, Katherine E. Stannard and Richard Kay Aldershot 1999.

Storms, Godfrid, Anglo-Saxon Magic- The Hague 1948.

Thomas Elyot"(1541) The Castel of Helth" Facsimile Edition –New York, Scholar's Facsimile and reprints n.d. Preface sig. Aiiii.

Toufic Fahd, Histoire des Sciences Arabes- Ed. Seuil Paris 1997.

Villuendas, M.V. La Trigonometria Europea en el siglo XI- Estudia de la obra de Ibn Mu'ad Barcelona 1979.

Watson, A.M. Agricultural Innovation in the Early Islamic World- Cambridge University Press. London 1975.