1. Two Cultures, Two Ecologies

[51] The basis of our comparative analysis of Islamic and Christian societies in the Iberian peninsula of the high middle ages rests on the perception that the two societies during the period when the frontier between them was stabilized (until approximately the mid-eleventh century) were ecologically differentiated. Thus our understanding of the agricultural economies and patterns of resource utilization pursued in each sector follows from a macroscopic view of human ecological adjustments, viewed in terms of regional geographic variation. This approach, which stresses cultural factors preeminently, seems more valid than any simplistic division of the peninsula into physically defined zones, the most usual being "wet" and "dry" Spain. For, whatever variable one might choose to define an ecosystemic frontier (vegetation cover, temperature, or precipitation), the frontier will differ in each case. It is, rather, the culture itself, through its patterns of settlement, that defines what frontier or which ecological limits are meaningful.

This is not to ignore significant climatological distinctions. It is well to bear in mind, for example, that the number of rain days per year typically diminishes as one moves from north to south along the Mediterranean coast. The pattern in the central and western regions is different: as much rain falls in the campiña of Andalusia as falls in Galicia, both well in excess of the figure for the Castilian meseta. The mean temperature generally rises from north to south. But when the two indices are conjoined in an attempt to delimit pluvious and arid zones, each attempt has produced different cartographic patterns.[1]

Our understanding of the traditional agrarian economics presently to be described is based upon three interrelated assumptions:

(1) The basic unit of analysis is the agroecosystem. All processes comprising an agricultural regime (whether agronomic, hydrologic, technological, or economic) constitute an interdependent system, each element of which is linked systemically to all the others.[52]

(2) Following Peter H. Freeman, we assume that "From an ecological perspective, traditional farming techniques are almost without exception well suited to environmental potentials. They could be viewed as ecologically 'harmonious' with the important proviso that human and domestic animal populations have not exceeded the carrying capacity (under traditional practices) of the environment."[2] Such a formulation provides a standard against which agricultural change can be analyzed and assessed.
When movements of culturally distinctive populations are involved, as they were throughout the course of the high middle ages, we assume that such migratory groups will tend to fill ecological niches which are most nearly in accord with their cultural traditions. We define "niche" broadly and with a cultural connotation: it is a zone with discrete ecological characteristics which a cultural group recognizes as familiar. In this view, when a human group fills an ecological niche an element of choice is implied. Anthropologists have recognized that migrating groups tend to move into areas "where their particular ecology is feasible."(3)

Further, this choice is conditioned by traditional perceptions of the environment, and by institutions and technologies developed for the pursuit of specific styles of agriculture.

When a group attempts to expand its old niche (for example, by the introduction of a new technique or crop) or when it, through conquest or migration, changes niches, then its success in the new situation will be a function of its capacity to adapt. A variety of cultural strategies are available: learning new techniques; attempting to continue an old style in an ecologically inappropriate situation (if a crop is valued highly enough, a low yield may be preferable to abandoning the crop completely); or selecting only those elements of a traditional system which will survive in new conditions.

In early medieval Iberia there were a number of significant ecological frontiers, separating zones in which the components of agroecosystems (dry farming, irrigation, herding, arboriculture) either differed or were conjoined in a different balance.

One frontier was delimited by the southern slopes of the Cantabrian-Pyrenean mountain system, separating a mountain herding and forest ecology from a sector characterized by cereal dry-farming, vineyards, supplementary irrigation, and local herding (e.g., the Duero Valley, the Plain of Vich). Another is that described by the northern limits of olive cultivation, which corresponded more or less to the stabilized political frontier between Islamic and Christian zones to A.D. 1000. After the opening of the Tajo Valley to Christian settlement in the wake of the conquest of Toledo (1085), the Tajo constituted a boundary between an agrarian system in which cereal crops were dominant, lying to the north, and a more typical Mediterranean landscape -- grapevines, olive trees, irrigated "oases" -- lying to the south, where cereal grains played a relatively minor role.

In the following sections, the dynamics of agricultural growth and change in Islamic and Christian Spain will be analyzed, as will the transitions necessitated by the breaching of ecological frontiers.

2. Landscape Change and Environmental Perception

When Baltasar Gracián observed that the Spain of his day was "just as God created her, without a single improvement made by her inhabitants, except for the small amount done by the Romans,"(4) he was expressing a perception of the immobility and stagnation of Spanish society of the seventeenth century. But in fact Gracián was mistaken. The cultural landscape of the Spain of his day was largely created in the high middle ages, as the result of the Islamic conquest and of the early modalities of Christian settlement. In the south, although the Muslims built on a Roman base, the landscape was substantially orientalized; while in the north the mountaineers, as they moved onto the plains, became acculturated, through a variety of agents, to Mediterranean patterns of agriculture and settlement.

All movements of organized colonization involve a prior image in the mind of the settler of where he is going. What he actually does when he arrives depends to a great extent on how well his image, which is conditioned positively or negatively by his old environment, meets the requirements of the new ecological reality.

Muslims and Christians alike perceived the Iberian environment as richly endowed with natural resources; at least, this is the view that predominates in the literary traditions of both peoples. That the
The notion, repeated in the Koran, of Paradise as a garden (al-janna, "The Garden") is symbolized in the form of Andalusi gardens, a few of which survive physically and some of which are described in literary sources. The form of these gardens, quadripartite rectangles with fruit trees arranged in rows parallel to an axial watercourse, was of direct Persian (though ultimately, perhaps, of Roman) inspiration. Such an arrangement is apparent in an eleventh-century description of the Hair al-Zajjâli, a renowned Cordoban garden, and is confirmed by the pattern of gardens, such as the Generalife of Granada, surviving from a later era. The symbolic value of the formal Islamic garden was as an earthly anticipation of paradise. In this sense, its contents of water, shade trees, and flowers were dictated by a generalized reaction to the desert environment, the traditional environment of Arabs, one that is dominated, of course, by aridity and conditioned by associations of the desert with fear and evil. It is striking, indeed, that desert images, a traditional theme in Arabic poetry, are almost completely lacking in Andalusi poetry, except as a device to introduce, for example, the paradisiacal, watery freshness of a place like Valencia, and this in spite of the fact that wide stretches of the southern peninsula (e.g., the Almerian hinterland) already resembled the face of the moon, having been deforested by the Romans.

Besides the image of the Koranic Paradise, there was a second theme characteristic of the Andalusis' perception of their environment: a consistent stream of comparisons with eastern Islamic landscapes. Places were valued not only for their distinctive characteristics but for their associations with other regions of the Islamic world, one of whose elements resembled that of a given Andalusi city or, more typically even, when a constellation of elements presented an environment perceived as identical to an eastern one. Partly this phenomenon has to do with poetic conceits linked to specific places (such as the likening of any river to the Nile), and partly to the prestige with which the Islamic East was regarded; but, more significantly, such allusions were the result of specific patterns of settlement in the peninsula by groups of eastern origin.

The climatic unity of the Mediterranean made possible the wholesale transfer of landscapes from one sector of the basin to others. Migrants, encountering a familiar ecological context, found that they were able to establish themselves in new territories without substantially changing their settlement patterns, agricultural regimes, or diet. To such colonists, in Fernand Braudel's apt characterization, "their journey simply meant finding in a new place the same trees and plants, the same food on the table that they had known in their homeland; it meant living under the same sky, watching the same familiar seasons." It was natural that the old associations would be remembered. Thus al-Himyarî likened al-Andalus to Syria in fertility and "the purity of its air," to the Yemen for its even, temperate climate, to India for its aromatic plants, to China for its mineral richness, and to Aden for its seashore economy.

Moreover, the process was self-reinforcing: because climatic conditions made landscape transference possible, such transference was encouraged as a matter of policy. The troops led by Balj ibn Bishr were
deliberately settled in habitats resembling their place of origin.\(^{(10)}\)

Thus the Egyptians were settled in Murcia, ostensibly because they were accustomed to irrigation agriculture, and later al-Himyarî reported that "Murcia is found on a great river which irrigates its whole territory in the manner of the Nile of Egypt."\(^{(11)}\) The obvious, but unwitting hyperbole, in comparing the Segura to the Nile is a reflection of the tradition to which we have been referring.

Most striking of all was the extensive Syrianization of the landscape that took place throughout the eighth century, first, through the settlement of Syrian contingents (*junds*) in such places as Seville and Valencia; second, through the wholesale importation of Syrian styles by the cadres of Umayyad clients who flocked to the peninsula after 756; third, by the deliberate policy of Umayyad emirs, 'Abd al-Rahmân I in particular. The introduction of Syrian agricultural systems, of hydraulic machinery used in Syria, of Syrian building techniques and decorative motifs, the deliberate importation of vegetation native to Syria -- these were among the many discrete elements that contributed to the Syrianization of Andalusi towns [56] and countryside. Here, we are concerned only with perceptions: that these constellations of elements were perceived of as being distinctively Syrian. Seville (Ishbîliya), settled by Syrian junds, was customarily and affectionately referred to by Arab writers and poets of east and west alike as Hims al-Andalus, after the Syrian town of that name. In a similar vein, ibn Sa'id, a thirteenth-century writer from Alcalá la Real (Granada), remarked that no eastern cities reminded him of home except for Damascus and Hama, a central Syrian town, and al-Shaqundî called Granada the Damascus of al-Andalus. Not surprisingly, the Damascus scenes in the film "Lawrence of Arabia" were filmed in Seville, a city generally acknowledged to resemble traditional Damascus more than Damascus itself.\(^{(12)}\)

The Isidorean tradition of the *laus hispaniae* was continued faithfully by Christian writers and poets. Here we analyze the perception of the environment of Old Castile as portrayed in the *Poema de Fernán González* and in the related version in the Primera Crónica General.\(^{(13)}\) In the first place, and similar to the concern of the Arabic commentators, primary emphasis is placed upon the temperate quality of the climate:

\[
\text{Tierra es muy tenprada syn grandes calenturas} \\
\text{Non faze en yvyerno destenpradas fryuras} \\
\text{Non es tierra en mundo que aya tales pasturas} \\
\text{arboles pora fruta syquier de mil naturas.}
\]

(Stanza 145)

(It is a very temperate land without great heat; there are no extreme cold spells in winter. There is no land in the world that has such pastures, fruit trees of at least one thousand kinds.)

This is clearly the perception of an optimum environment for a pastoral, mountain economy, an appreciation of which follows in the next stanza:

\[
\text{Sobre todas las tierras me'or es la Montanna} \\
\text{de vacas e ovejas non a tierra tamanna} \\
\text{tantos ha y de puerços que es fuera fazanna} \\
\text{syrven se muchas tierras de las cosas d'Espanna.}
\]

(Stanza 146)

(Of all the lands the best is the mountain; there is no land equal to it for cows and sheep; there are so many hogs there it is a famous feat; many lands are served by Spanish products.)
The positive valuation of the Old Castilian summer, which is in fact too arid to permit a three-course crop rotation, supports the strong identification with a mountain agroecosystem. These two stanzas are not Isidorean per se, but rather an affirmation of the Castilians' continuing identification with the traditional north Castilian ecology even after substantial shift to wheat-growing had occurred. There is no doubt that these two stanzas are cast within a Castilian frame of reference, although that famous line asserting that "Of all Spain, Castile is the best" does not occur until stanza 156; the intervening verses mix generalities drawn from the standard catalogue of the laus hispaniae genre, although highlighting certain products of mountain economies (e.g., beeswax, in the same stanza -- no. 147 -- which praises olive oil, a product not native to Old Castile and, in no. 148, wild game and river fish, which are typical of Castile).

The version in the Primera Crónica General begins with a Koranic echo, that Spain is like "el parayso de Dios," and stresses themes found in both the Isidorean and Arabic traditions, relevant mainly to the peninsula as a whole. Particular stress is laid upon (1) the theme of abundant water; the five principal rivers (Ebro, Duero, Tajo, Guadalquivir, and Guadiana); the good quality of river water ("el humor de los rios"); and the abundance of subsoil water -- "there never lack wells for each place that has need"; (2) the great variety and abundance of agricultural products, including wine, bread, honey, beeswax, sugar, silk, and saffron (Andalusi products); and olive oil (the Crónica, more faithful to the Isidorean tradition, says olio, while the Poema uses the Arabism azeyte, which was imported into Old Castile); (3) a great stress, standard in the genre in both Arabic and Christian versions, on the mineral wealth of the peninsula.

These stock perceptions, although similar, must have related to different economic situations. Castilians before the twelfth or thirteenth centuries could well conceive of their resources as abundant because, given the low population density of the region and the underdevelopment of urban economies, not much demand was exercised on the resource base. Thus, for the Castilians, the roster of minerals, a reminiscence of Roman mining exploitation, represented more a promise than a reality (with the possible exception of iron).

For the Muslims, mineral wealth had real meaning because these resources were utilized and the resource base, through the eleventh century at least, was adequate to the demand of urban artisan industry and the export trade. Only in the case of climatic perceptions do cultural differences play a substantial role in ecological assessment. Both groups perceived as temperate climates which are not now so perceived, the Arabs on the practical level because of their reliance on irrigation, which lessened their fear of aridity and provided a contrast to the expectations of a culture with traditions rooted in the desert; the Castilians because as mountaineers they had not yet broadened their agricultural base to the point where the climatic conditions traditionally valued became dysfunctional. In Castile, perceptions of agricultural impoverishment came later. Only in the fourteenth century, when the dynamic forces of the economy were located on the plains, not the mountains, when the agricultural economy had become substantially diversified, and when population pressure began to make excessive demands, did Castilians begin to perceive their environment more realistically. Only then were plaints raised in the Cortes about the sterility and poverty of the soil and the shortage, not abundance, of livestock and other foods.[14]

3. The Frontier as an Image and as a Creator of Landscape

Previously, I have intimated that in the Iberian peninsula during the high middle ages the borders or frontiers between Christians and Muslims were ecological in nature or, stated another way, they had clear ecological ramifications which not only colored perceptions of the frontier but which also necessitated ecological adjustments when those frontiers were breached, first by conquest, then by permanent settlement. Following in the spirit of the previous section, we shall first note differing
perceptions of the frontier and then examine the relationship between these perceptions and the way in which the frontier districts were organized.

For the Christians the dominant image of the frontier was a desert -- *locus desertus* -- a place that was uninhabited, due to the conditions following from the Islamic conquest, and uninhabitable given prevailing conditions of insecurity and threat of incursion. To a certain extent the apposite Arabic term for a wasteland, *mafâza*, played a similar role, but lacked the connotations of permanence and the symbolic weight that it held for the Christians. To give expression to a perceived division of the peninsula into two sectors Arab geographers created an imaginary mountain chain, based in part on fact and in part on perceptions that demanded a palpable barrier where none existed. This chain began in the east, somewhere between Barcelona and Tarragona (in effect placing the Catalan counties that had come under Frankish influence to the north of the Pyrenees), whence it proceeded southward towards Tortosa and then veered west and continued on a general east-west trajectory until it reached the Atlantic midway between the mouths of the Duero and Tajo. One group of Arab geographers, possibly representing a later tradition and whose outstanding representative was al-Idrisî, placed the eastern terminus of this system at Medinaceli, whence it continued due west to the ocean. This chain, called al-Sharrat (that is, the Sierra), was a more realistic portrayal of the Central Cordillera (which in reality proceeds in a markedly southwesterly direction from Medinaceli). Its massive, rectilinear depiction on Idrisî's map is an idealization of a social reality: the stabilization of the western frontier on the Duero line. In the east, Idrisî still portrayed Barcelona as lying to the north of the Pyrenees.

The interplay between frontiers perceived as significant and those which actually acquire geopolitical reality is complex. Through the tenth century the Duero River played the role of a geopolitical barrier and was so perceived by the rulers of the Astur-Leonese kingdom. For similar reasons, that of establishing an easily identifiable line of defense, the Central Cordillera had both geopolitical and symbolic significance for the Muslims. The Iberic system, on the other hand, which in the later centuries virtually determined the division between Castilian and Aragonese spheres of influence and therefore had enormous geopolitical significance, during this period lay mostly within al-Andalus and was not considered the most important factor differentiating eastern al-Andalus (Sharq al-Andalus) from the west. The tenth-century geographer, al-Râzî, for example, considered the direction of river flow and of prevailing winds as the most valid criteria for dividing the peninsula in two parts.

In both Islamic and Christian territories, frontier zones were, by their very nature, organized on a distinctive basis, inevitably entailing defensive structures embedded in a looser system of state control than was possible in the hinterlands. The Umayyads did not impose upon the frontier zones the full provincial organization into *kuras* but rather delimited three defensive frontier regions known as *thugûr* (singular, *thagr*), modeled after border organization in the eastern empire and generally translated "marches."

In earlier centuries the *thagr* was simply an empty zone separating Muslims from Christians, defended by a line of castles, and lacking a [60] full civil administration. Typically they were connected loosely with the emirate, and strong dynasties such as the famous Beni Qasi, descended from Goths and intermarried with the Navarrese nobility, were able to rule in virtual independence from Córdoba -- in this case, in the Upper March (*thagr al-aqsa*) around Tudela. During the Caliphate only two marches were accorded significance: the Upper, headquartered in Zaragoza, which controlled the region from Huesca and Tudela in the west to Lérida and Balaguer in the east, and the Middle March (*thagr al-awsat*), delineated by a line of castles along the Tajo (to the *south* of the Sierra, al-Sharrat, it will be noted), dependent politically upon Toledo, but organized militarily from Medinaceli.

The Upper March, whose population grew more dense in the course of the tenth century, particularly along the border with the Catalan counties, in effect became further differentiated into the old Upper
March defending the heartland of the Ebro Valley and an Eastern March (thagr al-sharqi) whose defensive orientation was apposite to the Catalan military frontier. The Upper March, due to its dense population, acquired greater political vitality than the other frontier regions of al-Andalus and, concomitantly, socio-cultural distinctiveness which persisted even past the time of Islamic domination: Aragonese Moriscos emigrating to North Africa in the sixteenth century still distinguished themselves as tagarinos, men of the thagr, a confirmation of the cultural cohesiveness of the area.

A similar situation prevailed in the frontier areas of the Catalan counties and much has been written about the so-called Spanish March - Marca Hispanica -- a term that until quite recently was generally and mistakenly applied to the entire region that eventually became Catalonia. In fact, as Maravall demonstrates, those areas referred to as marca were not organized parts of the Frankish kingdom south of the Pyrenees, as once thought. In reality, the term connoted just the opposite: a lack of organization, a zone of imprecise changing boundaries open to enemy incursions and defended by castles and other military installations, much like their Islamic counterparts.

Indeed the marca, as Maravall concludes, was not a term applying to any one area, but to a variety of frontier regions, a term analogous to the Castilian usage of extremo, the edge of settlement, wherever that happened to be. In Catalan usage, the two terms marca and extremus were intermixed -- extremum in ipsa marchia, in ipsa marcha extrema -- and in 1017 the monks of San Cugat, at that time an outpost near the frontier, spoke of the need to build defensive installations "in barren marches and in solitary places, against the pagans."

Similar concepts of the frontier prevailed in the west, where the frontier of Galicia was referred to as extremos Galletiae fines and where Sancho II was known as king of Castile et in omnibus finibus eius (in all its ends), where fines has the sense of marca. The land south of the Duero was called Extremadura -- which in the tenth century designated the region just south of the Duero encompassing Zamora and Simancas, but which later, as the frontier advanced southward, came to acquire its present geographical connotation, the lands to the south of Salamanca along the Portuguese border, including Cáceres, Mérida, and Badajoz, all well within the Andalusi hinterland during the high middle ages.

The defensive nature of frontier life can be vividly appreciated in surviving place-names that reflect military structures erected on both sides of the line. By mapping these names, one can get a sense of the frontier in motion as Christian lines advanced, and as Muslims built new lines of defense. In toponymic maps, this process is manifested in the marked regression of Latin-derived military place-names and their substitution with Arabic-derived names.

In areas of continuous Christian settlement, where large numbers of Goths took refuge from the conquering Muslims one finds names derived from the Gothic wardja ("centinel"), such as Guardia and La Guardia in Galicia, Asturias, and particularly in Catalonia on the southern frontier of the marchlands. Names derived from castrum, "fort," and its diminutive castellum are also found in relative abundance in the northern kingdoms -- the name of Castile itself being the most obvious example -- and these names become less dense as one moves southward to encounter names derived from the Arabic qasr; "castle," and qal'at, "fortress" -- for example, Alcázar, Alcalá, Calatayud ("Ayyub's fort"), Calatrava, names which occur in peak density along the northern line of Islamic defenses as in the provinces of Lisbon and Zaragoza.

Not all military emplacements were as heavily fortified as castles. The defensive strategy in medieval warfare placed great reliance on watchtowers which served as advanced positions to warn against enemy incursions, particularly in lightly settled areas on the frontier. Names derived from turrem, "tower," abound in the north and even increase toward the south, for as the Christians grew in military power they placed less reliance on castles and more on building a military communications
network. Names from the corresponding Arabic term, *burj*, concentrate below the stabilized frontier and represent the apposite phenomenon on the Islamic side. Two functionally related Arabisms, *almenara* and *atalaya*, both meaning watchtower, are found on both sides of the line: *atalaya*, in fact, is a good example of an Arabic military term, representing an initially superior technology which was adopted at an early date in the Christian kingdoms.

In the eleventh century, with the invasion of Almoravids, the Muslims introduced a new form of defensive installation: the *râbita* or frontier headquarters of religious ascetics who served in the holy war against the infidel, giving rise to place names such as La Rábida (in Castilian; Ràpita, in Catalan), as well as to others expressed in Arabic with a borrowed Latinism *munastîr* (from monastery, as in Almonacid in the province of Castellon).

Finally, one finds the name *frontera* itself, attached to various sites which at one time or another found themselves on the boundary, from Aldeasaca de la Frontera in the province of Salamanca, to the many towns so named in Andalusia (Jerez, Aguilar, Vejer), representing the advances of the thirteenth century.\(^{23}\)

Pierre Bonnassie has noted that Christians and Muslims living in close proximity to one another in the northeast of the peninsula had different perceptions of the same "frontier." That part of al-Andalus stretching from the north of Lérida to southern Pallars had been until the tenth century a region of relatively low population, not well integrated into the Islamic state. The region became substantively Islamized only in the tenth and eleventh centuries, but even then there was no hard line of political demarcation as connotated by the modern sense of frontier. Indeed, Christian and Islamic settlements intermingled to a certain degree and the Muslims considered their own those areas in which Muslims were settled.

For the Christians, on the other hand, their settlements in the same regions were regarded as tenuous outposts of civilization in an environment highly colored by insecurity and charged with fear, a place (as described by some monks from San Cugat in 1022) of "great terror and trembling" and to which terms like "solitary" and "deserted" were consistently applied. The very end of this territory -- the *marca ultima* was regarded as a no-man's-land and those Christians who dwelt there were held by their coreligionists of the hinterland to be perverse and depraved men, doubtless because they benefited from trade with the Muslims.\(^{24}\)

\[^{63}\] The same perceptions of fear, solitude, and desertion are even more pronounced in many references to the Duero Valley in the ninth and tenth centuries. In future sections there will be ample discussion of various aspects of Claudio Sánchez-Albornoz's theory that, through warfare and the conscious policy of Alfonso I, who was said to have transported the Christian population of the valley en masse to the northern mountains, the Duero Valley had become *wholly* depopulated in the wake of the Islamic invasion, an extreme literalist interpretation of the admittedly reiterated descriptions of places within the valley as barren, deserted, and uncultivated. Beyond whatever value the term *locus desertus* may have as a description of reality, we must however also agree with Ramón Menéndez Pidal that it had a "rhetorical" value, or rather what I think is more accurately characterizable as a perception of a human landscape whose density of settlement was extremely low.\(^{25}\)

Indeed the basic element in the perception of the frontier by Castilians and Leonese of the ninth and tenth centuries was the awareness of the paucity of their own population in comparison with the great numbers of their Muslim adversaries. Such perceptions emerge regularly in accounts of early battles with the Muslims: for example, the tens of thousands of Muslim troops said in the Chronicle of Alfonso III to have been defeated by Pelayo's tiny band at Covadonga. In the *Poema de Fernán González* the same point is made in the assertion that "thirty wolves" (that is, the Castilians) can kill 50,000 sheep.
A much quoted line from the same poem (stanza 217) describes the Castilians of the tenth century as "a few men gathered together in a small land" (eran en poca tierra pocos omnes juntados). This line occurs in some recensions of the poem in the opposite sense, muchos hombres juntados, which Sánchez-Albornoz used to support the picture of a Castile expanding through the dynamism of an exploding population.\(^{(27)}\) The first reading, that stressing low numbers, is supported by the corresponding section in the Crónica General, but moreover is more in line with what I believe was a general perception of the insignificance of Christian numbers compared to the Islamic colossus.

Uninhabited territory was regarded as fearsome not only because of its susceptibility to attack by the enemy, but because those living in such places, and their farm animals, were subject to attack by wild beasts. Thus when Alfonso VI placed the Segovia region under the control of the bishopric of Toledo, he noted that this newly settled and cultivated region \([64]\) had previously been the domain of bears and boars, the latter an animal much feared by peasants.\(^{(28)}\) There were, to be sure, uninhabited areas within Islamic territory as well. The countryside between Almanzora and Almería was described as sandy and sterile, and the plain extending from Almería to Cape Gata as a true desert.\(^{(29)}\) Yet the presence of such inhospitable country did not lead Andalusi poets to utilize the traditional images of desert environment found in the pre-Islamic poetic tradition, as one might expect; rather, the convention was to depict the entire peninsula as a vast garden, as we have noted. In general, the sterile areas of al-Andalus (māfāza) described in Arabic geographical literature were not frontier areas, with some exceptions, such as al-Rāzī’s characterization as māfāza of the area stretching between Albarracín and Toledo, which in the tenth century, while not densely populated, was also not directly on the frontier. Ibn Ḣanī associates areas devastated by Berbers during the fitna as having fallen prey to wolves; Abū Ishāq of Elvira, not a frontier region in the eleventh century, mentions wolves (claiming that they were less dangerous than faqīhs— the legal jurisprudential elite); ibn Muqānā mentions deserted areas (māfāwiz) around Alcabideche where wild boars roamed untrammelled.\(^{(30)}\) A māfāza was, therefore, a term describing a particular kind of environment, wherever it chanced to occur, whereas the locus desertus was inevitably associated with the frontier and the process of conquest and resettlement.

Nevertheless, in the late eleventh century there are signs that, as a result of the shift in the balance of power in the favor of the Christians, perceptions of the frontier were changing too. The Christians, growing constantly in strength and feelings of security after the death of al-Mansūr, felt their fear of the frontier subside accordingly. It was only at this time, for example, that kings began to grant charters of title to lands not yet conquered.\(^{(31)}\) A corresponding change, with the opposite sign, is in evidence on the Islamic side, especially on the Middle March, the pressure point which felt the full brunt of the Castilian thrust. Thus the Muslim governor of Calatrava expressed horror when Alfonso VI devastated the region and cut down all the trees.\(^{(32)}\) Dominique Urvoy has suggested that in areas where contact with Christian Spain was frequent, particularly the Middle and Upper Marches in the period following the collapse of the Caliphate, the pressure emanating from the north caused a generalized need for the revitalization of religious life among Muslims. In the Middle March this pressure was felt and sublimated in two ways. First, it \([65]\) produced heterodox figures such as al-Talamanqî (from Talamanca), who was accused of Khârijism, and ibn Shaqqal-Layl, a student of eastern Sufi mysticism. Second, Urvoy also associates the particularly rich development of Islamic law (fiqh) in the Middle March with its strategic location, implying that another reaction to pressure was a retreat into legal formalism and rigidity.\(^{(33)}\)

In this section my concern has been to indicate some of the ways in which political and cultural confrontation were shaped by the presence of the frontier -- many frontiers -- first, a stabilized one, then a boundary in more or less constant flux and motion; and then to show that the frontier was not
only a real entity, but a set of perceptions which influenced attitudes and action on both sides. Further aspects of the frontier phenomenon, such as its social repercussions, its economic ramifications, and its role in cultural diffusion, will be dealt with in appropriate sections below.

4. Dynamics of Settlement and Growth: al-Andalus

Comparison of the ecological adjustments made by Muslims and Christians in the high middle ages is made difficult by the disparity of available evidence. Generally, data on settlement, land-use patterns, and the habits and customs of everyday rural society is much more detailed for Christian Spain than for al-Andalus. On the other hand, the Arabs spawned a well-defined agronomic and geographical literature which provides information, particularly regarding crop dispersal and the acclimatization of new crops, totally lacking for the northern kingdoms.

Nevertheless, a comparison is valid. Both people exploited irrigation agriculture, dry-farming, arboriculture, and herding. Not only the balance among the four agrarian subsectors, but the scale of agriculture generally and its relation to the rest of the economy, differed substantially from south to north, in accord with ecological realities and preferences and in response to differing socio-economic factors. Yet certain analogous processes took place on both sides of the line: clearance of land at the expense of forest, the diffusion of new crops and techniques, the use of stream water for irrigation, the persistence of Roman practices.

Roman Spain, it is well to bear in mind, was agriculturally distinguished for the large-scale production of cereal grains, olives, and grapes, of which the former two were typically grown in large units to increase the profitability of these crops for export. Irrigation was practiced, and the continuity of its practice in certain zones, such as the Valencian huerta, from Roman times to the present is proved. Nevertheless, the agricultural economy was geared to dry-farming of high-profit export crops on latifundia, and irrigated vegetable gardens played no major role in this system. Nor does stockherding appear to have played a significant economic role, although the Celtiberian tribes of the mountainous hinterland practiced transhumant herding of sheep and goats, and cattle were raised in the lush lowland meadows of the Guadalquivir basin.

In contrast to this picture, the pattern of agriculture that emerged in al-Andalus over a four-hundred-year period included:

1. the steadily increasing predominance of irrigation agriculture and consequently of crops dependent upon artificial water supply;
2. the initial association of this kind of agriculture with foci of Arab settlement in lowland river basins;
3. the relegation of the other agricultural sectors (dry-farming, arboriculture, herding) mainly to non-Arab peoples;
4. an increase, over Roman times, in the economic significance of sheepherding; and
5. a corollary of all of these—a progressive and general retreat of wheat cultivation, a movement to which many signs point but for which proof is inferential.

The balance among agrarian sectors in Islamic Spain was related to, and its contours partially determined by, ethnic cleavages along ecological lines, whereby the Arabs reserved for themselves and their Neo-Muslim or Christian tenants the fertile lowlands as areas for the development of hydraulic agriculture; the Berbers maintained a pastoral and arboricultural economy in the mountains; and cereal dry-farming was continued by the indigenous population, whether Christian or Islamized. The division of agricultural sectors along ethnic lines, clearly delineated at first but tending to become blurred over time, only serves to underscore the fact that the agricultural regime typified in the Andalusi aeronomical treatises of the eleventh and twelfth centuries was a phenomenon explicable not merely in
economic terms alone but as the result of complex processes of acculturation and cultural diffusion. The association of irrigation with Arabs, the increasing tendency to rely on this kind of agriculture to support the expanding urban economies of the great Andalusi cities, must indeed, given the numerical insignificance of Arabs in the population, lead to the conclusion that a vast movement of acculturation had taken place, and that people whose ancestors had been dry-farmers became irrigators through the learning of new techniques and, perhaps more importantly, by acquiring through emulation of the dominant group's life-styles, different dietary and culinary tastes, supportive of a shift to irrigation agriculture.

The problem is further complicated by the fact that the ecological cleavages may not have been as neat as once supposed. It is generally agreed that Berbers occupied three foci of settlement, encompassing much of al-Andalus and nearly all of what is now Portugal: (1) the southern mountains from the Sierra Nevada and the Serranía de Ronda in the east, to the Niebla-Algarve region in the west, with a very dense nucleus to the north of Córdoba in the Sierra Morena; (2) the northwest, including Mérida, the Tajo and Mondego valleys, with centers in Talavera, Coria, Medellín, Astorga, and Coimbra, communicating with another nucleus in the upper Duero region; and (3) the entire mountainous region of the Middle and Upper Marches, and particularly the mountainous hinterland of Valencia, including the whole of the present province of Teruel. Recent studies have demonstrated that the Berber impact was even greater. Pierre Guichard has demonstrated that much of the Valencian lowlands, all of which were irrigated and which were previously thought to have been densely settled by Arabs, in fact included numerous Berber settlements, a conclusion supported by the configurations highly suggestive of Berber tribal settlement in the huertas of Gandia and Murcia. Then Jaime Oliver Asín, in a dramatic essay on Castilian place names, has recently demonstrated the permeation of zones well to the north of the line of stabilized settlement by Berber nuclei, probably Christian and Latin-speaking, but with similar forms of social and agrarian organization as their Muslim relations.

Not only was Berber settlement even more widespread than previously imagined, but the Berbers appear to have occupied niches once believed wholly organized according to Arab norms. This is not really surprising because, although North African Berbers were adept olive cultivators and practiced transhumant herding, they also practiced irrigation, both by stream flow, in the small upland valleys in the Rif and Atlas mountains, in lowland plains (for example, around Marrakesh), and in the desert oases of the Sahara.

Arab settlement was densest in the valleys of the great rivers, the Guadalquivir (which was not, in fact, a region where gravity-flow irrigation in canals was much practiced) and the Ebro, where canal irrigation was characteristic. Other Arabic nuclei settled in regions later associated with verdant irrigated huertas (the jund of Damascus in the Granada region, that of Egypt in Murcia) but their effect upon the agricultural regime is not clear. The indigenous population, who had mainly been involved in dry-farming and arboriculture doubtless continued in their former pursuits, those who became tenants of Arab landlords being in a position to learn new agrarian technologies.

**THE MUSLIMS AND IRRIGATION**

Irrigation agriculture and hydraulic technology are themes that reappear throughout this book. This is due not only to their undoubted significance in the economics of both societies but also to the fact that, as Jacques Berque wisely recognized in his study of Berber irrigation systems in the High Atlas, water distribution arrangements are so complex and idiosyncratic that they can be treated as historical documents and provide a rich source of information concerning the structure of society in general and the processes of ecological adjustment and technological diffusion specifically. Furthermore, the role of irrigation in the economies of semi-arid states is so important that some authors have portrayed it as the central organizing feature of the society. Thus Karl Wittfogel portrays al-Andalus as "a genuine
hydraulic society, ruled despotically by appointed officials and taxed by agromanagerial methods of acquisition.”[38] In Wittfogel's conception, hydraulic societies are polities in which, through control of water sources, elites are able to exercise despotic control, through a bureaucracy which arises partly in response to the managerial and maintenance requirements dictated by a large-scale, hydraulically based agricultural economy and through manipulation of labor by various forms of coercion. In this context, he associates the polity of al-Andalus of the Emirate and Caliphate with those of Mesopotamia, Egypt, China, and other ancient societies where flood control and irrigation on large rivers were a major concern of the state. Medieval Spain is of further interest to Wittfogel as an example of a society that "crosses the institutional divide" from hydraulic to non-hydraulic society when, as a result of the Reconquest, the Christians, to Wittfogel the representatives of feudal norms of governance, conquered al-Andalus and fell heir to the physical structures of the irrigation system without having, he implies, the necessary institutional structures to perpetuate the system.

[69] Leaving aside for the next section the hydraulic implications of the Christian take-over of formerly Muslim-held territory, we find Wittfogel's views of Islamic Spain open to serious question, although they do raise issues of considerable importance. In the first place, the heartland of the Emirate and Caliphate was the Guadalquivir Valley, where large-scale irrigation from rivers, in the manner of the Tigris or the Nile, was not practiced and where state-controlled flood prevention measures were not needed. The sources record interest only in urban water supply projects, such as the canalization of water from the Sierra Morena to supply the Mosque of Córdoba, built at the behest of the caliph 'Abd al-Rahmán III. [39] Systems that more closely approximated the eastern "despotic" model, such as those of Murcia, Valencia, and particularly Zaragoza and the Ebro Valley, were all in areas of peripheral interest in the Caliphate, the latter frequently escaping its control completely. Second, if any institutional divide was crossed with regard to the organization of hydraulic agriculture, it was crossed not with the loss of al-Andalus to the Christians but more likely with the dissolution of the Caliphate into the Party Kingdoms of the eleventh century. Indeed, recent historians of Andalusi agriculture have seen in the break-up of the Caliphate a positive spur to agricultural innovation and growth in response to a political structure that favored the development of regional economies.[40]

The plausibility of this conclusion, which is inferential, depends on how one interprets the issues raised by Wittfogel: if al-Andalus was a hydraulic society in the classical sense then the dissolution of the Caliphate could have had only a deleterious effect on the hydraulic structure itself, insomuch as that structure must have been partially the creation of the state and needed the state's support to continue. If, as seems more plausible, there was no over-all investment in or administration of irrigation by the Umayyad rulers, then it is difficult to see how the dissolution of the Caliphate would have directly affected irrigation one way or the other.

Both of these arguments in fact tend to disregard a more basic point: that irrigation systems influence the power structure not through administrative or labor requirements but, in Robert Hunt's characterization, through the production of local surpluses which are then converted into tokens of power and prestige in the extralocal world.[41] The question is not who controls the water-source but who gets the benefit of agricultural surpluses produced as a result of irrigation-intensive agriculture. In the Islamic world the process of conquest and colonization jolted stagnant local economies, put money into circulation again, and caused a price [70] rise that provided a real spur to the development of craft trades and thus to urbanization. The beneficiaries of this development, the urban merchant class, were soon able to purchase land in the surrounding countryside and thus to establish a real dominance of the towns over the countryside.[42] This, and not the workings of a despotic bureaucracy run from the palace at Córdoba, was the process responsible for the creation of the typical urban-huerta landscape, a town surrounded by a belt of fields irrigated either from gravity-flow canals or by means of wells tapped by animal-driven hydraulic wheels. Once set in motion by economic growth and reinforced by
technological innovations, the process was self-perpetuating unless interrupted by a major economic catastrophe. Al-Andalus was able to avoid the decay which began to afflict other areas of the Islamic world as a result of the disruptions of the eleventh century, because the flow of Sudanese gold was never cut off. Although the Umayyad superstructure diverted a great proportion of the wealth generated by agricultural surpluses to the building of monumental structures, there is no reason to believe that a comparable amount was not diverted in the eleventh century by tribute paid by the Taifa kings to the Christians. Therefore, I do not see any real break in the economic development of town/huerta complexes but rather a steadily growing process which in the eleventh century may well have been stimulated by the development of regional economies, to the extent that places like Valencia, Granada, and Zaragoza, which had been very small towns during the Caliphate, now came to emulate Seville, by a process completely analogous to that whereby the latter city had grown.

The irrigation systems of al-Andalus were of two kinds, although the huertas resultant from their development were quite similar both in structure and in economic function. First, there were systems where individual fields were served by canals bearing water delivered by gravity flow either from a river or from a spring. Second, there were other huertas where individual fields were served by wells, with the water raised to the height of the fields by an animal-driven hydraulic wheel. In addition, fields could be watered by current-driven wheels, lifting water from a river or a canal, combining the two modes.

These irrigation systems were characterized not only by the specific technologies utilized but also by the manner in which water was distributed to the users. These customary arrangements lend to each system a distinctive stamp and permit an analysis of their origins and organizing principles. I must stress the inferential nature of the relevant data: there is little documentation surviving from the Islamic period and therefore our view of the irrigation arrangements followed must be developed on the basis of the rich documentation surviving from the centuries after Christians had taken over the systems, preserving Islamic customs, and from comparative study of traditional irrigation systems in contemporary Islamic countries.

The distribution of water among the eight canals of the Valencian huerta is a particularly useful example because the underlying principles of the distribution arrangements are well documented and quite easily associated with a specific Islamic model. The river, now called by its Roman name the Turia, but in Islamic times known as the Wâd al-Abyad (Guadalaviar, "White River"), was considered to be divided into successive stages, each stage representing the point of derivation of one main canal which drew all the water at that stage, or of two canals, dividing the water among them. At each stage the river was considered to hold twenty-four units of water. The twelve-base system, several other examples of which are noted below, is standard in many areas of the Islamic world and is clearly related to the hours of the day. A paradigmatic system, so structured, would envision a river divided into 168 units (representing seven days and nights, or 144 if a day of rest was customary). The units were not, however, expressed in hours, but as simple proportions of a whole. Thus, in times of abundance, each canal drew water from the river according to the capacity of the canal; in times of drought, the canals would take water in turn, for a commensurate number of hours or a proportional equivalent. The same was true of individual irrigators (and herein lies the genius of the Valencia system): when the canal ran full, each irrigator could open his gate as he pleased, but when water was scarce, a turn was instituted; each irrigator, in turn, drew enough water to serve his needs (this style of irrigation was by submersion of the field, typically to a standard depth of an ankle). But he could not draw water again until every other irrigator in the system had his turn. Thus a relatively equal distribution was ensured, both in times of abundance and of scarcity, and no measurements of time or orifice of delivery were needed.
It is clear that this system is a close approximation of that of the Ghûta, or irrigated farm belt, of Damascus, where the Barada River is divided into stages where the river is held to be divisible into twenty-four qîrâts. The Damascus system, studied in the 1930's, does not reduce as easily as the Valencian to a division involving a one-week turn, but the organizing principle is clear nonetheless.

Yet if the river of Valencia was organized according to Syrian principles the process of diffusion raises some issues that are difficult to resolve. If the system was transplanted by elements of the Syrian contingents who entered al-Andalus with Balj ibn Bishr in the 740's, then one must posit an extraordinarily rapid process whereby nomadic troops from Arabia had settled in the 630's and 640's in irrigated areas around Damascus, learned the traditional distributional system (which was already old, judging by the permutations in the twelve-base structure which appear in the Caliph Hisham's division of the Barada in 742). and transmitted it to their grandsons, who although practicing irrigators, volunteered to fight in the west with Balj. This scenario seems improbable, the more so since it now appears that many of the early settlers of the Valencian huerta were Berbers -- the Favara canal, second largest in the huerta, for example, derives its name from the Hawwâra Berbers. A similar pattern is observable to the south in the huerta of Gandia, where the Vernisa River is apportioned by a twelve-base system, whose complex permutations make it impossible to figure out the original rationale (once this was forgotten, as by Christian times it had been everywhere, infinite permutations were possible by doubling, halving, or otherwise changing the units). Moreover, the secondary canals tend to have names compounded with Beni, suggesting a typical Berber settlement pattern with individual tribal units controlling an entire canal.

It is more likely that the Syrian model was imposed upon a population of Berber irrigators by an Umayyad governor, particularly during the early years of the Emirate, when the Syrianization of the landscape was a generalized phenomenon. This might well have occurred in the first quarter of the ninth century, when the Valencian region was ruled by 'Abd Allâh, a cousin of the Emir al-Hakam I, called al-Balansî ("The Valencian").

A probable factor in the willingness of Berbers to learn eastern styles of water distribution was the lack of large rivers in North Africa; therefore, when they arrived in Spain, where river irrigation was possible on a scale that demanded a more complex kind of organization, the imposition of eastern norms was a logical and practical solution. Ya'qûbî, a late ninth-century eastern author, describes Valencia as a region inhabited by Berber tribes who did not recognize Umayyad authority and who had a river called the Shukr (the Júcar). The irrigation systems of the Júcar were organized along generally "Syrian" lines.

The markedly public character of water in the Valencian-Syrian system is an inheritance from Roman law, as are the notions of allocation of water to individual farms in proportion to the area watered and the idea of controlling a limited supply of water by assigning more specific rights, organizing turns, and so forth. Other features of Andalusi irrigation systems, such as the responsibility of the individual irrigator for the maintenance of that portion of the main canal that abuts his property, were common to all Mediterranean irrigation systems and are found in the water law of Mesopotamia and other ancient societies. Regulations were enforced by elected or appointed officials who are known only by their names, surviving in Christian practice of the later middle ages-the sâhib al-sâqiya, "master of the canal," possibly an urban official deriving his power from the qâdî, and entrusted with the enforcement of traditional distribution arrangements and the overseeing of canal and diversion-dam maintenance. Curiously, two of these officials became kings of Valencia during the Taifa period, a testimony to the power and prestige of the office and to the predominant role of irrigation agriculture in the regional economy.
Farther south, in the oasis-like communities of Elche, Novelda, and Alicante, irrigation water was also distributed in canals, but the distribution arrangements were markedly different. Early in this century the French geographer Jean Brunhes noted that water distribution arrangements in southeastern Spain seemed to group into two families. In places where water was more or less abundant -- the river systems of Valencia, Gandia, Murcia -- water rights inerred in title to the land and were distributed proportionally according to the system described above. But in Elche and other areas where the water supply was relatively limited (the sources were typically springs, rather than rivers), water rights tended to be privatized, alienable from land, and allocation was by fixed-time units which could be bought and sold. Brunhes correctly identified a pattern in the distribution of irrigation systems according to climatic and hydrological factors. But he did not note the cultural dimensions of the phenomenon, for these oasis systems have a South Arabian profile. Thus the water measurement units in Elche are clearly identifiable with those of Yemeni systems, where the units represent time values ranging from portions of an hour to a full day.

The Yemeni model seems also to have prevailed in the oases of the Sahara, a fact which contributes to a picture of Berbers learning Yemeni customs from Arab immigrants and then, in turn, transferring them to the Iberian peninsula. Not only the measurement units, but the techniques of measurement (for example, the sinking clock), as well as the officials who presided over the measurement and sale of water, manifest a pattern of diffusion from South Arabia across the Saharan chain of oases and into Islamic Spain. These patterns are clear in the systems that have been studied comparatively. Similar studies are needed of other Islam-derived Spanish systems, such as those of Murcia, Granada, and the Ebro Valley, all of which have analogous but highly idiosyncratic features.

The diffusion of specific models of irrigation arrangements with clear precedents in the eastern Islamic world forms the context in which the introduction of new crops is fully comprehensible. Yet the systems discussed do not form a complete picture of Islamic irrigation practices. Much land came under irrigation, owing to the development, not of surface water sources, but of ground water, on the basis of the diffusion of lifting devices, originally of Persian inspiration, throughout the Islamic world.

THE NORIA REVOLUTION

The introduction of the noria in any district has always had revolutionary consequences upon agricultural productivity. If introduced into an area where river irrigation has been practiced (for example, Ptolemaic Egypt), it lessens the dependence of gravity-flow canals on fluctuations in the level of the river (the Nile, in the case of Egypt) by using nongeared, water-driven wheels to raise the water. The geared wheel, moved by harnessing animal traction to it, may have an even more dramatic economic effect. Since it is relatively inexpensive to build and simple to maintain, the noria enabled the development of entire huertas, intensively irrigated on the basis of individually owned smallholds. The diffusion of both kinds of wheels had the effect of increasing agricultural production, allowing for a greater density of population, and of providing agricultural surpluses with which to underwrite urbanization.

In al-Andalus, water-driven wheels were found in conjunction with canal systems in Murcia, where the mammoth wheel at La Ñora was driven by the current of the Aljufia canal, and most typically in Toledo, described by al-Idrisî (twelfth century) as having around it gardens interlaced with canals on which were established wheels for irrigation, and Córdoba, where al-Shaquundi (thirteenth century) described 5,000 norias (probably including both lifting and milling devices) on the Guadalquivir. The extensive aeronomical literature of eleventh- and twelfth-century Andalusi writers strongly accentuates the role of irrigation agriculture to the detriment of dry-farming techniques. But the irrigation described is not fluvial but from wells from which the water is lifted by a noria with a chain.
of pots and deposited directly into a channel or into a holding basin. Indeed, these writers came largely from Seville and Toledo, two cities to which the cultural center of gravity had shifted after the fall of the Caliphate and where Valencian-style irrigation was not practiced.

In the ancient Mediterranean world, generally only winter crops were grown, with each field yielding one harvest every other year. The Arabs introduced a variety of new crops of Indian origin (of which the Andalusi agronomists were fully aware -- al-Tignarî of Granada makes reference to "Indian agriculture"). Since these crops required heat, they were grown in the summer. Thus a rotation of crops became the norm, and irrigated fields yielded as many as four harvests yearly. The far greater number of annual plowings required by the new crop succession and the resultant water loss tended to make Muslim irrigators meticulous in their regard for the water-bearing capacities of each kind of soil. More kinds of soil were used than had been the custom in antiquity, and the aeronomical handbooks indicate that each soil type should be fully exploited. Ibn Bassâl, whose treatise was based completely on practical experience, distinguished between ten classes of soil, assigning to each a different lifesustaining capability, according to the season of the year. He was insistent that fallow be plowed four times between January and May and, in certain cases (for example, cotton, when planted in the thick soils of the Mediterranean littoral), he recommended as many as ten plowings.

The agronomists believed that irrigation was necessary, along with fertilizer, as an improver of soil and, according to prevailing natural philosophical notions, as a regulator of soil temperature. Reflecting the highly refined practical techniques of eastern garden agriculture, they stressed the necessity of cultivating in such a way as to preserve the maximum amount of moisture in the soil. In irrigated fields, this involved a carefully planned field system of raised ridges and furrows, oriented in such a way as to make the best use of the slope of the land. In some cases, this involved "correcting the land" so that the water would run equally through all the furrows, so that submersion could be achieved with maximum benefit to all plants without letting the water stagnate. These notions were standard throughout the Islamic world wherever irrigation was practiced and gave rise to distinctive patterns of rectilinear fields approaching a square shape, containing low irrigation levees to regulate the flow of water, and with ridges and furrows typically arranged in the form of a comb. The purpose of the comb, one of a number of furrowing patterns used, was to slow the velocity of flow on fields whose slope exceeded one degree or more, thus enabling a farmer to irrigate without terracing his land. This was the common form of furrowing for vegetable crops, with serpentine furrows used for row crops, and its diffusion has been traced from Central Asia to southern Spain.

THE ARAB "GREEN REVOLUTION"

The introduction and acclimatization of new crops, a powerful component of the economic growth of al-Andalus, followed the same pattern of diffusion as the irrigation systems and techniques used to grow them. Of the plants brought by the Arabs to the peninsula (those whose Arabic names passed into the Spanish languages are noted in Table I), the seeds of many must have been brought by anonymous cultivators. Yet more formal methods of introduction are recorded. 'Abd al-Rahmân I, whose nostalgia for the Syrian landscape has been mentioned before, was personally responsible for the introduction of several species, including the date palm. A variety of pomegranate was introduced from Damascus by the chief judge of Córdoba, Mu'âwiya b. Sâlih, who personally presented the plant to the Emir. From the palace at Córdoba a Jordanian soldier named Safâr took a cutting and planted it on his estate in the Málaga region. This species, called safrî after the soldier, subsequently became widely diffused. Early in the ninth century the poet al-Ghazâl of Jaén returned from a mission to the east with the doñegal fig, which became one of the four or five staple fig varieties in the country. The full description of the poet's modus operandi is symptomatic of the way cultural elements were diffused in that cosmopolitan
"The doñegal (dunaqâl) fig was introduced by al-Ghazâl when he went from Córdoba to Constantinople as an envoy. He saw that fig there and admired it. It was forbidden to take anything from Constantinople. [77] He took the green figs and put them with his books that he had wrapped up, after he had unfolded the strings and wrapped them again. When he made his departure, he was searched and no sign was found of it. When he arrived in Córdoba he removed the plant from the middle of the twine, planted it, and cared for it. When it bore fruit, he went with the fig to the lord of Córdoba and it amazed him. He told him about his ruse in procuring it. The lord thanked him for his deed and asked him about its name. Al-Ghazâl replied: 'I do not know what its name is except that when the one who picks it gives some of it to someone he says "Dûnahu qawli" which means "Oh my lord, look!" and so the Commander of the Faithful named it Dunaqâl.'"

Such details are all too infrequent in the literature, but represent what must have been a common pattern. [58]

Newly introduced plants were frequently acclimatized in royal gardens, first in that of the Umayyads in Córdoba and, in the eleventh century, in the royal gardens of Toledo (where the agronomists ibn Bassâl and ibn Wâfid were both employed) and Almería. Many of the new plants were either tropical or semi-tropical varieties that required irrigation, or were temperate species that could only be stabilized in a semi-arid environment by irrigation. Therefore the Andalusi agronomists paid particular [78] attention to the water requirements of each species. Ibn al-`Awwâm was precise in stipulating the water needs of mountainous plants transplanted in the lowlands. [59]

Chief among the newly introduced irrigated crops were sugar cane, which in al-Andalus was watered every four to eight days, and rice, which had to be continually submerged. Cotton was cultivated at least from the end of the eleventh century and was irrigated, according to ibn Bassâl, every two weeks from the time it sprouted until August 1. The Andalusis were self-sufficient in cotton and exported it, according to al-Himyarî, to Ifriqiya and as far south as Sijlmâsa. [60] Oranges and other citrus plants were also irrigated, as were many fruit trees and dry-farming crops which do not need to be watered but which produce greater yields if they are.

The introduction of new crops, combined with extension and intensification of irrigation, gave rise to a complex and varied agricultural system, whereby a greater variety of soil types were put to efficient use; where fields that had been yielding one crop yearly at most prior to the Islamic invasion were now capable of yielding three or more crops, in rotation; and where agricultural production responded to the demands of an increasingly sophisticated and cosmopolitan urban population by providing the towns with a variety of products unknown in northern Europe.

**ARBORICULTURE**

Irrigated field crops were complemented by the standard Mediterranean vine and tree crops, the most important of which were olives, the fig, and grapes. Although these three crops were generally considered to occupy the same ecological niche -- hill country and unirrigated plateaux -- fig trees were frequently used as borders on irrigated fields and grapes were often irrigated, when practicable, to increase yields. [61]

We have mentioned the olive before in connection with the frontier: the pale of Muslim settlement did not extend beyond the northward limits of olive cultivation. The Arabs had not introduced the olive (although they may have imported new trees from North Africa to supplant those which perished in the drought of the eighth century); the plant had been a staple of Hispano-Roman agriculture. But the stress
that Islamic culture placed upon it, seen, for example, in the almost exclusive use of olive oil for cooking, to the exclusion of animal fats, left a lasting mark: in [79] contemporary Spanish usage the tree has a Romance name -- olivo -- while the fruit and oil are known by Arabisms -- aceituna, aceite, from al-zaitūna, al-zait.

The best-known olive-growing region in al-Andalus was the area to the west of Seville called al-Sharaf -- Aljarafe -- "situated upon a high plateau of red earth, of an area approximating forty miles square, which can be traversed walking always in the shade of olive and fig trees." Aljarafe oil was highly esteemed and was exported to the east (to Alexandria, according to al-Shaquandi). At the time of the conquest of Seville (1248), Julio González calculates the number of olive trees in the province at more than two and a half million, producing five million kilos of olives. By the end of the century, however, tithes on wheat were more lucrative than the olive tithe, although both were considerable. The distribution of land use of the Aljarafe today (30 percent in olives, 23 percent in wheat, 35 percent in forest, and 12 percent divided among other crops) is probably close in profile to what it was at the end of the thirteenth century, no doubt representing some shift in emphasis toward wheat-growing after the Christian conquest. Other olive-bearing areas of the peninsula may not have matched the Aljarafe in density, but were well known for olive cultivation: Idrisî referred to the Lérida-Mequinenza region as the īqlîm al-zaitûn -- region of the olives. [62]

Although figs may not have had the economic importance of olives, they afford an excellent example of the intensification of agriculture in Islamic Spain, manifest in the dazzling variety of the fruit available to consumers. In the tenth-century Calendar of Córdoba, the Latin ficus (fig) translated the Arabic shajar "trees" (the specific word for fig is tin), indicating that the fig was so numerous that it became, by antonomasia, the tree. From the standpoint of production for the export market, Málaga was the most important fig center, the city being surrounded on all sides by figs of the Rayyo (rayyî, also referred to as mālaqi, Malagan) variety, "which is the best class of figs and the largest, with the most delicious pulp and the sweetest taste." Malagan figs were exported by Muslim and Christian traders and sold in Baghdad (according to al-Shaquandi) and as far away as India and China, where they were valued for their taste and their ability to preserve it over the full year's travel occupied in their transport. In the Sierra Morena a wide variety of figs was grown, including the qūtiya (Gothic), sha'arî (hairy), and doñegal. [80] The fig was also of interest to the agronomists: al-Hijārî reported that in the Garden of the Noria in Toledo there was grown a kind of fig tree whose fruit was half green and half white. [63]

Contrary to what might be expected given the Koranic prohibition of wine-drinking, the spread of Islam not only failed to blot out the grapevine, but in fact, owing to the inventiveness of Islamic horticulture, the number of varieties was even increased. In spite of indications in the Repartimiento literature that grapes were not widely grown in certain areas of southern Spain where vineyards later flourished -- Seville, for example -- the Arabic sources indicate that grape-growing and even wineproduction were widespread. Although we can assume that wine production was to a certain degree attuned to the needs of the Christian and Jewish communities (there was a state-operated wine market in the Secunda district of Córdoba, where many Christians lived, in the time of al-Hakam I), there was a tremendous market for grapes, raisins, and wine among Muslims as well. This is the result of Iraqi, not Christian, influence. Abû Hanîфа's dictum declaring the legality of drinking datewine was extended by Andalusi jurists to include all wines. Widespread wine-drinking became current during the wave of Iraqi influence in the reign of 'Abd al-Rahmân II and was said to have been introduced by Ziryâb, the famous singer and arbiter of style. Al-Shaquundi reports that in Málaga the vineyards stretched on uninterruptedl, and that in Ubeda (not a place associated with Christian minorities) grapes abounded to the point where there was no market in them. Another well-known Andalusi grape was the qanbani grape of the Cordoban campiña, perhaps the most productive dry-farming area in the country. [64]
I stress that wheat-growing in al-Andalus is a problematical question because it assumes a variety of processes, none of which are, as yet, well documented or well understood: first, the extent to which areas that had been wheat-producing before the Islamic conquest became abandoned (e.g., in frontier buffer zones) as a result of the conquest; second, the extent to which remaining wheat production suffered diminution from the migration of Christian wheat-growers to the northern kingdoms; third, the extent to which Neo-Muslim wheat-growers may have migrated to the towns, abandoning their farms; fourth, the acculturation of dry-farming Mozarabs and Neo-Muslims to the irrigated style of agriculture, which did not place as high a value on wheat.

It is difficult to state with certitude exactly what varieties of cereal grains were grown in al-Andalus. It is generally thought that the Arabs introduced hard wheat (*Triticum durum*) to Europe, and that this is associated with the wheat called *darmaq*, which passed into medieval Castilian as *adârgama*. Millet, which was the lower-class staple, was replaced by sorghum (Arabic *dhura*, yielding medieval Castilian *aldora*), imported from the Sudan, no doubt by Berbers. Sorghum played in al-Andalus the same social and nutritional role as that played by rye in Christian Spain; however, rye was also cultivated by the Muslims, who called it by its Romance name, *shantiyya* (see Table 2). There can be little doubt that there were powerful climatic justifications for the replacement of soft wheat and rye by hard wheat and sorghum, respectively. Hard wheat was resistant to heat and drought, and sorghum, "though it required some moisture in the early part of its growing season . . . could mature in a summer that was very hot and dry." The conduciveness of the dry Iberian air to long-term storage of cereals was much remarked by medieval geographical writers. According to Yâqût, the wheat of Toledo could be stored in silos for a century. As a result of more efficient storage capability, seasonal and drought-year shortages could be better handled and the price of grain stabilized.

Nevertheless, soft wheat varieties must have persisted in many parts of the country -- those varieties known in Andalusi Arabic by Romance-derived names -- as well as rye, cultivated in traditional form by Christian or Neo-Muslim dry-farmers.

Many regions were mentioned as being famous for the quality of their wheat: the campiña (*qanbaniyya*) of Córdoba; various places with the name Fahs (meaning plain) -- Fahs al-Ballût, to the north of Córdoba and Fahs Qâmara, near Colmenar; the plain of Cartagena, and that of Sangonera, near Lorca; the region between Cintra and Lisbon in the far west. After the conquest of Valencia, Muslims typically abandoned the irrigated areas, but remained to cultivate wheat in such places as Viver and Jérica. Yet in spite of the impressive list of places renowned for the quality of their wheat, al-Andalus had a chronic wheat deficit which, for the reasons stated, must have grown greater with the passage of time. The Andalusis imported grain from North Africa from the ninth century on and, after the Christian recuperation of the Duero Valley, from León (notably during the reign of Ferdinand II, 1157-1188). In this context, ibn Khaldûn's comments on wheat are revealing. He noted, for example, that nomadic Arabs were habituated to importing wheat "from distant places" owing to their great mobility, a statement, which, it seems to me, can be read as indicative of a low value assigned to wheat in the traditional hierarchy of Arab food tastes. Indeed, elsewhere ibn Khaldûn remarks that among Arab nomads milk fills the role occupied by wheat among sedentary peoples. Indeed, the two primary dietary characteristics of urban dwellers, according to ibn Khaldûn, is much (too much) meat and fine wheat. He attributes the good health of Andalusis to their spartan diet of sorghum and olive oil. There are other indications that wheat was not highly valued: in the version of ibn Bassâl's treatise on agriculture published by Millás Vallicrosa there is no discussion of cereals at all. We know that ibn Bassâl wrote about cereals (ibn al-‘Awwâm quotes him), yet in the irrigated milieu of the Taifa capitals...
the man who copied ibn Bassâl's treatise may simply have found the sections on cereals irrelevant. On the other hand, ibn Bassâl's prescriptions on rice-growing are included in full detail.\(^{(69)}\)

The Islamic invasion and subsequent depopulation of the clayey, wheat-growing regions of the Duero Valley and other areas lying in the [83] buffer zone between the two cultures led to an immediate decline in wheat production from what it had been in Roman times. The wheat-growing areas lying within Islamic domain continued to be cultivated by the indigenous population, whether Mozarab or Neo-Muslim. But, since non-Muslims were not allowed to bring new land under cultivation, the Mozarab agricultural establishment was effectively frozen. It could only decline.\(^{(70)}\)

The continuous flow of Mozarabs from al-Andalus to the Christian north must have contributed to a continued decline in wheat production, accentuated in the ninth century, when thousands of Mozarabs departed in the wake of martyrdoms at Córdoba and other disturbances in the reign of ’Abd il-Rahmân II. That the Mozarabs who settled in rural León came mainly from wheat-growing areas -- Toledo, Coria, Córdoba -- is evident from the names of the settlements they founded: Toledanos, Coreses, Villa de Cordobeses.\(^{(71)}\) Moreover, although these settlers frequently built irrigation canals and other water-conduction channels, they did not know the Arabic irrigation terminology which later passed into common usage in much of Christian Spain, in spite of their bilingualism, which the documents reveal in other areas of life. One can only conclude that these cultivators had been wheat-growers in al-Andalus and had never been exposed to irrigation agriculture.\(^{(72)}\) The migration of Neo-Muslims from the countryside to the cities to join in the burgeoning artisanal economy must also have added to the decline of wheat production.

### BALANCE BETWEEN IRRIGATION AND DRY-FARMING

The relationship and balance between irrigated and dry-farming land was of particular interest to Muslim jurisprudents because the two land-use types were taxed according to different scales. Both the tithe and the land tax were adjusted to the productivity of land, which was largely a function of the way it was watered. Land which was not watered artificially was called \(ba'l\), as opposed to irrigated land -- \(saqi\). Settlers had to take pains to establish the legal nature of their land -- a caution which is recalled by surviving place-names: Albal, Balbacil, Balazote, the last paradoxically meaning "dry land of the diversion dam" (\(ba'l\) al-sudd), possibly indicating a change in tax status.\(^{(73)}\) The tithe was less on irrigated lands than on unirrigated, to recompense the cultivator for his additional labor. The land tax, however, was attuned to the productive value of the [84] land and tended to be higher for irrigated lands, a practice carried over by the Christians.\(^{(74)}\)

Scholars, moreover, attempted to characterize the entire country in these terms. Malik, the legal authority whose precepts were most followed in al-Andalus, had said it was illicit to pay rents in kind. But other scholars held that only in irrigated areas like Egypt, where the harvest was assured, should payment be always demanded in coin. In dry-farming areas such a demand would be unjust, owing to the undependability of harvests. It therefore became a topic among jurists to decide whether al-Andalus should be considered an irrigated land or a dry one. The Egyptian jurisprudential school counted al-Andalus an irrigated land, due to its supposed hydrological similarities with Egypt; but the Medinese school claimed that it was a dry-farming area, that it needed more rainfall than Egypt, and that, therefore, payment in kind should be accepted. The latter opinion was followed in Islamic Spain.\(^{(75)}\) More interesting, perhaps, than the actual intricacies of taxation are the varying perceptions that eastern Muslims had of the Andalusi environment. It seems fair to say that al-Andalus was generally viewed by Arab authors as a place where irrigation agriculture predominated but where it was needed precisely to overcome serious climatic obstacles. Drought was an ever-present threat and its deleterious effects
multiplied if continued over a number of years.

To summarize the processes of agricultural development in al-Andalus, we may agree with J. A. García de Cortázar that the broad pattern of Andalusi agriculture, at its inception at least, resembled that of Visigothic Spain with a monetary economy superimposed upon it.(76)

But that is not the whole picture, because over time the original balance among agricultural sectors changed radically, the major shift being a reduced reliance on extensive cereal culture and a greater reliance on intensively cultivated irrigated gardens surrounding the towns. The Muslims expanded the productivity of sedentary agriculture by exploiting soils and microclimates not utilized to advantage previously, by introducing new crops, and by importing a hydraulic technology capable of sustaining them. The result of these processes, particularly those facilitating the intensive exploitation of individual parcels, was a filling in of rural space with a denser agricultural settlement, although the locus of this settlement gravitated towards the towns and alluvial valleys, leaving former wheatlands largely empty (or perhaps turned to pasture steppe-land). The [85] relationship between agricultural development and the herding and forest sectors is discussed in sections 6 and 7, below.

5. Dynamics of Settlement and Growth: The Christian Kingdoms

In many accounts of the history of medieval Spain the processes of "Reconquest" and "Repopulation" are presented as linked events, settlement following, in ever more southward-lying bands, upon the successive conquests of segments of the peninsula won from the Muslims. But the linkage of the two processes ought not to obscure the internal modalities and mechanisms of settlement, which depended upon specific demographic and economic contours of the populations involved and which, in the final analysis, were as important in shaping the future societies of the Christian kingdoms as the conquest itself.

Indeed, the earliest phases of settlement were not dependent on conquest so much as on the occupation of such no-man's-land as the Duero Valley and uninhabited buffer zones in the west of the Catalán counties of Barcelona and Ausona. Differing dynamics of population growth accounted for the differential pace of these early movements. In Catalonia, the mountains were overpopulated and empty spaces on the plains filled up quickly, by 950. In León and Castile, the mountainous populations of the Cantabrian-Basque chain that fed the settlements of the tenth century did not have enough weight to provide as dense a settlement, and therefore the transfer of mountaineers to the plains in the west led at first to dispersion and not, as in the east, to a new phase of population growth. The Braudelian notion of the mountains as a continuous source of population for the plains can be accurately applied to both foci of tenth-century settlement, but this fact alone is not necessarily indicative of "overpopulation" (in any case, a relative term with numerous dependent variables) uniformly throughout the Cantabro-Pyrenean chain.

Nevertheless, there were numerous similarities between the modalities of settlement in the east and west of the peninsula, where one can describe a process of the steady settlement of plains which stimulated cereal and grape production, causing a massive change in the landscape as well as corresponding change in the dietary habits of people formerly used to a mountain ecology.(77)

THE SCALE OF SETTLEMENT

[86] In Castile and Leon low population density controlled both the pace and contour of settlement throughout the entire period. In the ninth and tenth centuries demographic growth was vegetative at best. Although we can describe the signs of progressive intensification of settlement, few regions became densely populated. Accurate figures are rare and the best data comes from a relatively late period. Even so, Gimeno's figures for Soria in 1270 reveal a range in density of rural settlement from 1.8 persons per square kilometer to 6 at the greatest.(78)
The dispersion of settlement, inevitable owing to the tremendous excess of land relative to the scant number of settlers, can be appreciated from various estimates of the average population of a hamlet (villa or vico, which García de Cortázar defines as a segment of land surrounding a dwelling and including a variety of appurtenances such as cultivated fields and meadows, mills, and a range of undeveloped land) or a village (aldea, a larger aggregation, whose description with an Arabism is significant). There is no hard line between a hamlet and a village, but the average population seems to have ranged from 12 to 60 in Castile, and from 20 to 90 in Catalonia, where settlement was denser. For even less well-populated areas, the figures range from an average of 10 per village in Soria and the early Extremadura to 4 or 5 households for Upper Aragón.

The small scale of these settlements can be appreciated not only from the scant population figures, but from indications, however impressionistic, of the size of buildings and parcels. In 915 the Count Berulf recounted having settled certain villages in the Valley of Ardón "with small buildings" (ex parvis edificiis). There are numerous indicators of the smallness of parcels, not the least of which was their scant monetary value: a parcel worth only one sheep must have been minute.

Another indication of scale of settlement is the slow evolution of the road network. The early settlers of Castile and León settled along established roads (calzatas, which usually indicated a Roman road) and had no neighbors. By the mid-tenth century, in certain better populated areas, like the Mozarabic foci in the Valley of Ardón, field perambulations in land transfer documents began to show a plethora of newly established roads (karrales), indicative of the filling up of the empty space. In the eleventh century, specific mentions of "new roads" (via nova) demonstrate the deliberate creation of communications and transportation networks by ecclesiastical landlords who felt the need to organize their dispersed holdings more efficiently.

SETTLEMENT OF THE PLAINS

The Muslims' onslaught and their early retreat behind a climatic frontier resulted in the depopulation of substantial buffer zones between the two societies. The extent of the depopulation differed from place to place. Both in the far east and far west, early Muslim aggressivity seems to have resulted in the removal of substantial numbers of the original inhabitants: Septimania, the Roman province straddling the eastern Pyrenees, may in the eighth century have been as deserted as the Duero Valley; likewise, large areas of Galicia were said to have been barren for a long time after the devastations of the Muslims -- according to the Chronicle of Alfonso III, who, however, may have overstressed the generality of the depopulation of Christian lands in order to magnify his own colonization attempts.

The extent of the abandonment of the vast valley north of the Duero -- first stressed by the Portuguese historian Herculano and, more recently, by Claudio Sánchez-Albornoz -- is not fully ascertainable, but must have been substantial. On the whole, the indirect evidence leads to the conclusion of widespread population loss: the Muslim raids and fleeting occupation, combined with the severe drought and famine of the mid-eighth century, would have induced Christians to move northward into the mountains, which were both more secure and climatically more favorable to subsistence, while the lack of toponymic specificity in charters describing the first settlements of the ninth century (that spring, those hills, rather than named sites) lends credence to a picture of desertion.

On the other hand, the direct evidence, particularly a few much-quoted passages from the Chronicle of Alfonso III, seems hyperbolic and to smack of special pleading: in it, Alfonso I is said to have captured thirty towns from the Muslims and then to have retreated, taking the indigenous Christian population back with him to Asturias; and Ordoño I (Alfonso III's father) is said to have circled the cities of León, Astorga, Tuy, and Amaya with walls and to have populated those places with refugees from Islamic Spain (populo partim ex suis, partim ex Spania advenientibus implevit); finally, Alfonso III stresses that
the area had been depopulated by the Islamic wars, and revivified by his own efforts, a statement taken by Sánchez-Albornoz as indicative of the survival in the early tenth century of the memory of total depopulation earlier. Others have argued, with considerable justice, that the depopulation could not have been total, and that some population, particularly in remote areas, must have remained.

In any case, it is not necessary to argue for the totality of depopulation to agree that both the Duero Valley and the plains of Vich and Barcelona (captured by the Christians in 801) were characterized throughout the ninth century by a very low density of population, which made these regions desirable for settlement.

The attractiveness of empty land for settlement was always tempered by strategic considerations imposed by the proximity of the frontier, on the one hand, and the relative aggressiveness of the enemy, on the other. The towns resettled by Ordoño I were all of strategic importance, necessary for stabilizing the frontier and providing secure bases for rural development. For similar reasons, some lands of marginal agricultural value were cultivated to achieve, for defensive purposes, a relatively high population density in strategically important regions, only to be abandoned later as the frontier advanced. The rhythm and quality of settlement were directly affected by the pattern and intensity of Muslim raids: thus vineyards, for example, which required year-to-year stability for their development, could not be planted too close to the frontier or in areas subject to raids, and, further, when the raiding became intense, as during the reign of al-Mansūr (end tenth century), frontier landlords, such as the monastery of Cardeña, actively sought northward-lying land, towards the headwaters of the Ebro, in order to ensure continuity in cereal production in a region safe from attack. The southward expansion of monastic estates was directly affected by the proximity of the enemy. Cardeña's early properties were nearly all to the north of the Arlanzón River, since the region to the south was still, in the early tenth century, considered too insecure (with reason; the monastery was completely destroyed by a Muslim raid in 920). The same strategic factor explains why, during this period, monastic landowners such as San Millán de la Cogolla maintained a very careful balance between the production of cereals, dependent on extensive dry-farming (where extent was limited by strategic considerations), and intensive cultivation, by irrigation, of riverside properties close to the mother house. As the frontier receded, the agricultural balance tilted decisively towards extensive cereal cultivation.

The availability of land led to idiosyncratic juridical, social, and economic forms characteristic of frontier settlement, both in the Duero Valley and in Catalonia. The typical form of acquisition of property was the aprisio (presura, in Castilian), a modality of "squatter's rights" in Germanic customary law which, owing to the exaggeratedly low density of population, came to acquire particular vigor in medieval Spain. Juridically, aprisio was a formula whereby any person or group of persons could lay claim to land simply by virtue of occupying it (presura) and by bringing at least a portion of it under cultivation (escalio). (How much had to be cultivated need not be debated; the idea was to establish an economically viable unit, including cultivated land, pasture, and woodland.) Land conquered from the enemy was, under Germanic law (and Islamic law as well), held by the sovereign, and, in the case of presura, was considered an implicit grant, made explicit (by virtue of thirty years settlement) only at the time of its alienation, when title had to be shown. The net result was something close to an allode, held by a free proprietor, outright or by emphyteutic contract.

The mood of early presuras is captured in a description of a church in the Mena Valley founded by an abbot named Vitulo in the late eighth century, in a charter dated 800: "there we established the aforementioned basilicas; we cultivated; we planted; we built there houses, cellars, granaries, with wine-presses and cauldrons, orchards, mills, apple trees, grapevines and other fruit-bearing trees." Frequently such documents stipulate that the presura was accomplished with the signatory's own hands (de manibus meis), a striking evocation of the reality of life on the frontier.
Prominent in the early settlements of the Duero Valley were individual clerics or groups of monks, attracted by conditions of a rigorous life conducive to the cultivation of ascetic values. These small churches (which in reality resembled other presuras, with the added appurtenance of a church or chapel) tended to coalesce, by donation, into the great monastic domains that emerged in full relief towards the middle of the tenth century to fulfill, in effect, urban functions in a land devoid of towns. Much of the best agricultural land in León and Castile was controlled by monasteries, to whose values, needs, and tastes we must look for standards by which the landscape of the newly occupied territories was organized. (89)

Migration of mountain people to the plains entailed a shift from a high-altitude herding economy with limited agricultural horizons to a Mediterranean economy along Roman lines. This shift was furthered, in León particularly, by the massive migration of Mozarab dry-farmers from al-Andalus, beginning in the mid-ninth century, as a result of the [90] persecutions during the reigns of 'Abd al-Rahmân II and Muhammad and continuing in a diminishing but constant flow over the next century or so. These Mozarabs, settling as did migrants from the north, in joint family units or as groups of monks, organized a vast area of the Leonese Duero Valley. For example, the Valley of Ardón (originally called Mahamut or Mahmude -- Muhammad -- after an early leader) was settled almost completely by Mozarabs who clustered in small hamlets bearing an indelible Mozarab stamp (e.g., Villela de Aiub; Banuncias from Beni Iuniz, also called Villa Iuniz; Villa Vanizati, from Beni Zaid). (90) These Mozarabs migrated from a country where a Mediterranean agriculture along classical lines, with important new technological and aeronomical innovations, was flourishing. Perhaps one great symbol of the Mozarabic impact on the Leonese economy was the taste for olive oil, the importation of which played a significant economic role. But the fine structure of the Mozarabic impact on the landscape north of the Duero has not yet been investigated.

The settlement of the Duero Valley was a process which continued throughout the entire period covered in this book. The Christian victory at Simancas in 939 made possible the settlement of the Tormes basin (around Salamanca, well south of the Duero), but the situation there remained unstable and insecure until the conquest of Toledo in 1085, which opened for settlement the entire region between the Duero and the Tajo. In effect, the process was never completed, owing to the constant loss of population and to the inability of the stable population to generate much internal growth. In a situation where, as in the settlement of the American west, there was always more land available farther towards the frontier, it was difficult to maintain the stability of any settlement. Every new settlement entailed the loss of productive labor from an older settlement. Early presuras were frequently abandoned as the settlers moved on to a new situation either more attractive agriculturally, socially (remission of dues and services by lords as an incentive, for example), or economically (rural to urban migration). These would then be granted out again, if new men could be found to take the place of those departing. Villagers were able to coerce their lords into lightening feudal obligations by the threat of mass migration southwards. Other lords, desirous of attracting population, offered incredible exemptions, such as the active recruitment of criminals and wanted men and excusing of crimes, even homicide, granted in some of the early town charters. (91) The most general trend was short rather than long migrations, however: leaving the hamlet of [91] one's birth for a neighboring village, or moving from one seignorial domain to another where terms were more attractive. The net result was that lords were reluctant to have new villages in their own domain populated with their own men, and so they sought to entice the men of other lords or homini excusi, men who had no lords, to populate their lands. The obvious friction that such a strategy produced led to general attempts by lords in the late tenth century to prevent short-range migrations. A necessary corollary to this inherently unstable demographic situation was the persistent cheapness of land throughout the tenth century. Sánchez-Albornoz gives illuminating examples of the phenomenon: the barter of a parcel of land in 946 for cloth; another in 949...
for a goat and a kid; and one in 959 for a ram and a quantity of iron.\(^{(92)}\)

The occupation of the plains of Catalonia was accomplished through analogous processes, although with a more definitive conclusion: empty spaces filled up (essentially by around 1020) with a consequently significant leap in population density that allowed the agrarian economy to enter a new phase of intensification which in turn underwrote the urbanization of a metropolis -- the first in Christian Spain -- Barcelona. Settlement was achieved by the migration of mountain people first to the foothills and then in mid-tenth century onto the plains of Vich and Bages, expanding around A.D. 1000 to the middle Segre region in the south of the county of Urgell, the western frontier of the counties of Ausona (Vich) and Barcelona, and, farther south, the lower Panadés littoral.\(^{(93)}\) Here aprisio seems to have played a similar role as an incentive to settlement, although it developed in a social and demographic context different from that characterizing the Duero Valley. Few areas where aprisio was first practiced (in the late eighth century) -- the mountainous counties of Pallars and Ribagorza, and the northern Catalan counties (Gerona, Ampurias) could have been devoid of rural population. Therefore, the new settlers, holders of aprisiones, came into conflict with older established residents, who held land under much less favorable conditions, and their lords. Thus aprisio assumed the status of a legal fiction used for political reasons to dispossess older inhabitants who had remained on the land throughout the Muslim occupation.\(^{(94)}\) As in the Duero Valley, the peasantry was composed generally of small freeholders, paying a simple cens under an emphyteutic contract, and the process of settlement was likewise directed primarily by ecclesiastical lords. The counts may have preferred to let monasteries direct the actual work of settlement, as when Borrell granted a monastery specific rights to make aprisiones in a specified region. The monastery of San Cugat was typical of a tenth-century Catalan monastic establishment involved in bringing no-man's-land on the southern frontier under the plow. After the mid-tenth century there was little good land available inland from the frontiers and by the end of the first quarter of the eleventh, according to Bonnassie, the colonization effort had lost the spontaneity characteristic of aprisio and those who aspired to such grants had to accept harder contractual terms.\(^{(95)}\)

**THE EXPANSION OF CEREAL CULTIVATION**

Abbot Vitulo's description of his presura is an adequate illustration of the implantation of a Mediterranean agricultural regime, based on the cultivation of cereal grains and grapevines, in an area which since the early eighth century had been, where inhabited, largely an extension of mountain herding economy. Such a phenomenon involved a number of cultural processes, including the migration to the mountains of plainsmen used to a Mediterranean diet; the learning by mountaineers of a new kind of agriculture, with the consequent readjustment of dietary tastes and habits; the role of Mozarabs in transmitting such information; technological innovations permitting such a large-scale transfer of agrarian regimes -- all of which are poorly documented and only dimly understood. In broad outline, the movement can be characterized by a steady replacement in a southward direction of wood- and grazing-lands, by cereal and vine cultivation, whose pace and rhythm (increasing dramatically in the tenth century in Catalonia, the eleventh in the Duero Valley) was determined by the generally upward movement of population.\(^{(96)}\)

Grain was transformed into food by means of water power, and the building of the water mill is perhaps the best documented and most reliable indicator of the diffusion and intensification of cereal growing. There is a plenitude of documentation attesting to the building of mills in the Cantabrian and Pyrenean mountains in the ninth century and all over Christian Spain in the tenth. Both Muslims and Christians understood this technology (see Chapter 7). The profusion of tenth-century documents relating to the alienation of shares in mills (they were built by collectivities of free peasants, when not by monasteries or lay lords) demonstrates the progressive spread of cereal production in substitution of meadows and
woodland in León and in Old Castile, in the vicinity of [93] Burgos. The mention of clusters of mills (such as three in Nájera acquired by the monastery of San Millán de la Cogolla in 1038) indicates the expansion of cereal production in a given regional focus. The documentation increases in the eleventh century and falls off in the twelfth, indicating that expansion of cereal production north of the Duero had slowed down or stopped. Mills were especially typical features of the Catalan landscape, and profuse documentation exists from the ninth century on; again in an area where cereal production was particularly intensive, as in the plain of Barcelona in the late tenth and early eleventh centuries, mills tended to be clustered together, built in lines along the rivers. (97)

Generally the center and east of Old Castile and much of the Leonese plain were good wheat lands. Cereal production expanded there steadily throughout the eleventh and twelfth centuries when population pressure in some areas of Castile even forced the conversion of vineyards and flax fields into wheat. (98) Cereals were grown on open fields under a cultivation system called año y vez, meaning that a field was planted to wheat one year and left fallow the next. In many areas no rotation was practiced, but in others a two-course rotation appeared when organized fallowing became an economic necessity. The advantage of a two-course rotation was that local herds could be grazed on half of the fields annually, a stratagem that was unnecessary as long as there was abundant uncultivated land (monte). In areas where local herding was particularly strong, a further adaptation was made in the form of cultivo al tercio, which freed more space for fallow grazing. Given the summer aridity and the continued use of the light Roman plow, it was never feasible to introduce the northern European three-course rotation, with a spring sowing; the only way to increase wheat cultivation was by extending the arable land at the expense of pasture and woodland and, later, even of vineyards and irrigated fields. The increasing trend away from local towards transhumant herding -- also an effect of increased use of land for agriculture -- heightened the dependence of cultivators upon fallowing, to make up for the loss of local sources of fertilizer. (99) Yields were accordingly very low, from 3.4 to 4.2 to 1, for wheat and barley (thirteenth-century figures from Silos, which compare unfavorably to the normal northern European yield of 1:5 for wheat and 1:8 for barley). (100)

Wheat was rich people's food. In the Poema de Fernán González the count is offered barley bread by a monk who had none of wheat to [94] provide. The usual poor man's bread was of rye or comunà, which was wheat and rye mixed. Lords could determine production allocation among the different cereals by demanding payment of dues in kind of wheat and barley in varying ratios. Thus in the sandy soils of the Galician littoral, where rye grows better than wheat, wheat cultivation still gained (with accordingly low yields) because the lords demanded it. (101)

Grain was not only grown for human consumption but also was harvested green for forage, particularly for stabled animals. These herrenales (ferraginers in Catalonia) were typically enclosed and for the use of individual proprietors. Oats were rarely grown before 1000, but increased dramatically in production in Catalonia in the first half of the eleventh century. Another important fodder was the turnip, which made a great impact in Galicia in the late thirteenth century when its cultivation permitted a substantial reduction in fallowing. The climatic situation there made a genuine rotation system possible: winter corn was harvested in the summer; then turnips were planted and harvested in the spring; then spring corn (barley and millet) was planted and the cycle repeated itself every two years. (102)

VINEYARDS AND FRUIT TREES

The other cornerstone of Christian agricultural expansion was the grapevine, whose diffusion entailed a complicated interweaving of cultural, climatic, and economic processes. That the diffusion of the grape was intimately linked to that of monasticism is beyond doubt; the Benedictine rule specified that monks should drink approximately one litre of wine per day. The demand for wine resulted in the progressive conversion until the end of the twelfth century, first of wasteland, then of cereal land, into vineyards.
As cereal production expanded, the value of vineyards rose. Grape cultivation was especially attractive to the small free proprietor. He could cultivate a vineyard without recourse to a plow and sell the surplus, placing him in better position to maintain his freedom than the small cereal farmer, dependent on others for milling and for iron implements.\(^{103}\)

Grapes became ubiquitous; however, the standard mentions of *vineas* in lists of appurtenances frequently refer to backyard vines rather than to medium to large-scale agricultural operations involving a commercial crop.\(^{104}\) Nevertheless, more and more land was converted to grapevines,\(^ {95} \) as demand rose. In Castile-León vineyards may have been primarily converted from cereal-producing land. In Catalonia, where extensive terracing was carried out from the tenth century on, vineyards tended to invade hilly country, at the expense of wasteland. Because of a limited transportation capacity (the transportation of grapes and wine to the lord's residence was a feudal obligation in Castile), the scant commercialization in a society with virtually no towns, the unwillingness of peasants to invest in vineyards too close to the frontier, grapes were grown in many places where their cultivation ceased after the crop was commercialized: throughout León, where grapes were the most important crop, in spite of the acidity of the soil; in the Arlanzón-Upper Ebro region of Old Castile, where it is now considered too high and too cold for grapes, but where in the high middle ages they were grown anyway; in Catalonia, in the Pyrenaic foothills of the Upper Segre, the valley of Ribes, and the plain of Cerdanyà, "where in total defiance of natural conditions" they were grown for three hundred years.\(^ {105}\) The spread of grape cultivation in Upper Aragón in the eleventh century is of particular interest, in view of the marginal climatic and soil conditions there, but more especially in view of the highly reputed wines produced in the neighboring Islamic kingdom centered in Huesca. It may well have been the case that although the Muslims grew grapes in plenteous supply, they produced only enough wine for the local trade, responding to what must have been a lower per capita consumption than was current among Christians. Indeed, the plethora of contracts for new vineyards in Aragón between 1150 and 1180 could only have meant that wine was being exported.\(^ {106}\)

In a poor Mediterranean society, with scant cereal production and an unvaried diet, figs and other fruits formed a significant part of the daily fare, especially of the poor man. When cereals were generally available, fruit trees declined as sources of staple food and their products acquired the familiar role of a dessert food. In the northwest of the peninsula, the apple was the most commonly grown fruit tree. Those of the Basque country were famous, and the southward migration of Basques surely entailed the diffusion of the apple. In wine country, apples and other trees were intergrown with vines or used as vineyard borders. Figs, pears, cherries, peaches, and plums were also widely grown and, wherever possible, irrigated. Of these, the first two were of particular importance, both in the west and east of the peninsula (note the incidence of place names derived from the fig tree: Figueiró, in Galicia; Figuera, Figueres, in\(^ {96}\) Catalonia). The Catalans in particular seem to have matched the Arabs in their mastery of grafting techniques -- and at the same time as the school of Andalusi agronomy was flourishing. A document of 1051 cites three varieties of pears all grown in the same garden.\(^ {107}\)

It has been noted that the Duero Valley lay north of the climatic limit of olive cultivation. Yet the taste for olive oil in cooking was widespread, as a result of the migration of masses of Mozarabs. Since it could not be produced locally, the Leonese had to import it from Zamora, which had been settled in the tenth century mainly by Mozarabs and which served as an entrepôt for the oil trade. The olive was not grown in Catalonia until the mid-tenth century, when isolated trees are mentioned as curiosities. By the early eleventh century it had become an established culture.\(^ {108}\)
IRRIGATION IN THE CHRISTIAN KINGDOMS

In dealing with the development of irrigation agriculture in the Christian kingdoms, we again face a complex pattern of cultural and technological diffusion. The Christians, like the Muslims, were heirs of Roman agricultural techniques, and irrigation was practiced by Hispano-Romans. Those Hispani -- descendants of refugees from the Islamic conquest -- who were resettled in the future Catalonia in the mid-ninth century were authorized by Charles the Bald to follow their old irrigation customs, to utilize "canals (aquarum ductus) for their necessities . . . according to ancient custom."(109)

Irrigation from perennial water sources by gravity-flow canals was a technology shared by all peoples of the Mediterranean basin.

Yet, in spite of the widespread diffusion of irrigation, one cannot describe any large-scale hydraulic agriculture, except in certain areas of Catalonia (and there not until the eleventh century). In the plain of León, where the hydrological potential for irrigation was excellent, (110) and in Castile as well there were numerous small monastic canal systems wholly contained within the demesne of the monastery. Throughout the entire period monasteries sought riparian land, where they would conduct water from diversion dams into canals to irrigate small vegetable gardens, whose produce was used to supplement the diet of the monks. (The pattern is significant, because it is indicative of the inability of Leonese and Castilian [97] society to commercialize the products of irrigation-intensive agriculture -- although not those of vineyards, also cultivated intensively.)

The manner in which water sources, particularly rivers, were utilized in the Duero Valley was shaped by the frontier situation, and the modalities of appropriation of water rights greatly resemble those of the American West and contrast with the public nature of water in the river-derived systems of Islamic Valencia. Almost all of the documentation indicates that water was subject to presura and that prior appropriation --"first in time, first in right"-- was the rule of the day. The Fuero of Logroño (1095) contains a perfect expression of this norm: "Whoever can find water for irrigating pastures and vineyards, or for mills or orchards, or wherever they might have need, let them take it."(111)

Prior appropriation by individuals was a consistent principle asserted in grants and pled in litigation over water rights. The monastery of San Isidoro in the city of León owned an irrigation system derived from a dam which the infanta Sancha had granted it as a monopoly. Other claims derived from presura. In 917, an Abbot Balderedo, also of León, successfully sued for the return of water diverted away from his mill on the Bernesga River, on the grounds that his ancestor had taken that water by presura in 875. On many rivers, monasteries, through the process of accretion of dams, mills, and canals through donation, could allege prior right. Therefore, in case after case, one notes that others seeking to use the water of such a river did so on sufferance of the monastery, as major lord. The monks of Ardón (León) were accustomed to grant the use of water downstream from their mill and brought action against a mill, claiming its ill effect on their own mill. It is clear that the monks claimed a proprietary interest in the water and that riparian rights asserted by downstream users could not hold up against the appropriative right of the monastery.(112)

Likewise, it was the policy of the monastery of San Pedro de Cardeña in Old Castile to control and exploit the water of the Arlanzón for milling and irrigation. The monastery received in donation an entire stretch of the river "from bank to bank" (impossible in Roman law, where the channel is always public); purchased a canal leading to the monastery of San Martín; and won rights to the water of another canal near Burgos in litigation before the count of Castile in 932. In the same region in 956 the men of Villavascones, a village near Burgos, had to negotiate with [98] the Abbot of San Martin for the right to use the river water for the purpose of irrigating their fields. The Abbot promised to give to the villagers and their council a specified, measured portion of the water that he and the monks had
purchased, so long as the villagers promised to maintain and clean the main channel. The grant was to remain in effect permanently, unless the villagers refused to clean the channel. Apparently the subject of the negotiation was the use of a canal system owned by the monastery. But the legal context in which the agreement was framed was the private absolute ownership of river water. The tendency in irrigation in León and Castile was for large seignorial domains, almost always ecclesiastical, to aggrandize the rights, ultimately by virtue of prior appropriation, through donations and purchase of water and water power, and for the free use of these to become increasingly out of the reach of small free proprietors, who in the ninth and tenth century had themselves been the owners or co-owners of mills and irrigation water, typically expressed in shares (so many parts of a mill) or in hours (the right to use water for a specified time), all of which is appropriative rather than riparian in nature. Characteristically, a dispute over Arlanzón water in 1178 was waged between Cardeña and a group of nobles; the resultant settlement (instituting a turn of five days of water for the monastery and three for the infanzones) was regarded as a loss to the monastery.  

The result of this appropriation of water by private individuals and institutions was a landscape of rivers bordered by local huertas, belonging typically to monasteries who absorbed their products, and therefore the absence of interconnected regional huertas. Quite distinct was the situation in Catalonia, where entire irrigated zones arose, in response to the demand of the urban market. The Catalan situation is unusual because irrigation there developed, in effect, as a byproduct of milling. Because of irregularity in the flow of the rivers, the mills were built on diversion canals at some distance from the source. Below the mill, a return ditch, the subtus rego, returned the water to the river, irrigating gardens (terras subreganeas) along the way. Around the year 1000, in Pierre Bonnassie's description, smallholders were creating the irrigation system, either individually or in collectivities of villagers, although lay and ecclesiastical lords tended to own most of the mills. The result was that by the early eleventh century Barcelona was surrounded by hortos subreganeos wherein were grown vegetables and fruit for the urban market. The parallelism with Andalusi towns is striking, as is the analogous role played by mills (in the plain of Barcelona) and norias (around certain Andalusi towns) in the development of irrigated huertas.

Land use in Christian Spain was divided in varying proportions among cereal fields, vineyards, irrigated orchards or gardens, meadowlands or woodland (which was used for grazing and gathering activities). New cultivation implied either a shift in agricultural regime or deforestation. In general, forests yielded to cereal lands, which in turn were partially diverted into vineyards. The development of a cereal-grapevine economy on the plains set up a natural rhythm of commercial exchange with the mountains, which were poor in wheat, rich in wood products and animals. The system was built by small, free proprietors but over a period of time tended to become aggrandized by powerful lords, particularly monasteries. In the last third of the thirteenth century the old equilibrium was broken by the seignorial cultivation of commercial crops at the expense of local consumption.

FROM PRESURA TO REPARTIMIENTO

As the war against the Muslims pushed the frontier southward, land was opened for settlement which was not largely empty but which contained an organized landscape, frequently with Muslim inhabitants. Thus, beginning with the conquest of Toledo in 1085, a new modality of settlement had to be devised. Rather than leaving the business of settlement to the will of individual settlers or groups of settlers, the royal administrations of Castile and Aragón took an active hand in the process through the surveying and apportionment of already developed parcels of agricultural land -- the method known as repartimiento.

The standards governing repartimiento differed from situation to situation: in Zaragoza (captured 1118 by Alfonso I of Aragón), Tudela (captured 1119), and Tortosa (1148), the urban Muslim population was
obliged to depart the city within one year, but rural landholding patterns remained intact in the verdant, irrigated huertas of the Ebro (including 25,000 acres around Zaragoza). In Mallorca and Valencia, James I strove to maintain intact the pattern of small irrigated properties which the Muslims had utilized so effectively, although a series of revolts beginning in 1248 led to an exodus of Muslims from most of the irrigated areas of the Valencia littoral. The Castilians generally followed a policy of sharing the towns with the Muslims and of keeping the structure of Islamic [100] agriculture intact where possible (e.g., Toledo). But the policy changed radically with the capture of Baeza in 1226, after which Muslims were uniformly expelled from Andalusian towns and from much of the countryside as well.

The case of Murcia offers a unique case of a double repartimiento, one Castilian, one Aragonese, permitting a comparison of styles. The town was originally captured by Alfonso X of Castile, whose notion was to effect a slow displacement of Muslims both from the town and from the huerta, maintaining the irrigation system intact, and to grant huerta land to townsmen as a means of holding them there. This process was aborted by the Muslim rebellion of 1264, which resulted in a new conquest by Alfonso's father-in-law James I of Aragón. James had since abandoned his original strategy (as in Mallorca) and attempted to create seignorial domains out of huerta with a subject Muslim population, believing that stability could be best ensured, not by Alfonso's middle-class community but by a strongly armed nobility. When Alfonso returned, however, he continued to move Muslims out of the huerta and replace them with Christian. (117)

Given these different strategies and outcomes, whose social significance will be considered later, there were three options available to the conquerors for the organization of agriculture in the newly won territories: the Muslim system could be learned and continued; northern dry-farming could be implanted; cultivation could be abandoned and replaced by sheep rearing.

Generally, Islamic irrigation systems were maintained intact. In the case of large, interlocking regional systems with long canals and complicated distribution procedures, the Christians had to take pains to learn the customs from the indigenous population. In the Crown of Aragón the procedure was for a nobleman to hold an inquest at which Muslim irrigators would explain how the system worked and then to issue an ordinance continuing the customary arrangements. Thus in 1106 Fortún Aznárez issued a disposition concerning the distribution of the water of the Irués canal, near Tarazona, based on how the water "used to run in the time of the Moors and as he discovered the truth ... from old Moors." The document then describes the system of turns among hamlets on the canal, the word for "turn" expressed with the Arabism ador. The canal was administered by Muslim-style officials, the çavacequias (sâhib al-sâqiya) of the city of Tarazona and the local alamis (from Arabic amîn), who oversaw the day-to-day functioning of the canal. A similar procedure [101] was followed a century later in the capture of Valencia: an inquest was held in Gandia by Peregrín de Atrosillo to ascertain the manner in which the Serpis River had been apportioned by Muslim irrigators; the sâhib al-sâqiya appeared at the hearing and, under oath, detailed the traditional distribution arrangements. Similar hearings must have been held in Valencia city itself, where the Syrian-style distribution system continued unchanged, and in a multiplicity of towns along the eastern coast, where the medieval documentation concerning irrigation frequently included a standard stipulation that water distribution arrangements should continue as they had been "in the time of the Moors."

In al-Andalus, irrigation systems seem to have been administered by urban officials, dependent upon the qadi (the sâhib al-sâqiya) or by autonomous communities of irrigators, in all probability organized along tribal lines. When these systems were captured, the former were easily assimilated into the Christian municipal structure, whereby the irrigation officers became employees of the town council. In the case of the autonomous communities, such as those of the Valencian huerta, tribal organization seems to have been supplanted by guild organization. This would have been natural, because most of the Christian immigrants who became irrigators had been townsmen in Catalonia and would have been
familiar with the organization of guilds and with the method of electing officers and assessing dues, all of which was superimposed upon specific distribution arrangements that had been devised by the Muslims centuries earlier.

The transitions were, on the whole, remarkably smooth, and the prosperity of Valencian towns in the later middle ages was owing in part to the continuance of a high level of production of huerta commodities for the urban market. The tendency, noted above, towards the patrimonialization of water does not appear to have affected the transition adversely, except in the case of the Segriá canal in Lérida, which became the private property of its early Christian administrator, Peter Raymond Çavacequia. The basic issue appears to have been the collection of the irrigation tax or cequiatge, which may have been misunderstood by certain of the early conquerors, who were used to collecting feudal dues on public services like ovens and mills and who failed to realize that the cequiatge was, in fact, not a tax, but a maintenance charge, without which the canal could not be maintained. In the case of Lérida, the town eventually (in 1213) had to purchase the canal. The irrigation tax of Jaca was granted to the Hospitallers in 1250, and the same appears to have occurred in various [102] small huertas in the kingdom of Valencia. Most of these usurpations must in time have reverted to the canal users, because the canals could not be maintained without the investment of the tax in the maintenance of the system.

After the conquest of Toledo and the securing of the Tajo and middle Guadiana basins, agriculture around the city remained much as it had been: irrigated gardens and vineyards, farmed mainly by Mozarabs, with frequent interstitial uncultivated fields (tierras blancas), representing parcels vacated by fleeing Muslims. There were also numerous olive groves (olivares), although, due to the loss of Muslim population, olive production did not regain its pre-conquest level until the fourteenth century. Dry-farming areas to the north of Toledo (Madrid, Guadalajara) and to the south (from Cáceres to Cuenca) were given over to cereal production, settlers receiving grants of open fields ad anni vicem, the customary biennial (año y vez) rotation (in individual parcels, each divided in two, rather than in communal fields). This was an interim economy. By the end of the thirteenth century, transhumant sheepherding had become the dominant form of agrarian enterprise throughout the central meseta.[120] In the heartland of Andalusia (Córdoba, captured in 1236; Jaén, 1246; Seville, 1248), since most of the Muslim population fled before the hardened policies of the conquerors, the agrarian regime appears to have suffered a radical transformation. Fields were abandoned for pasture; some cereals were cultivated according to northern methods (land transfer documents specify that cultivation was to be at año y vez); and a high level of olive production was maintained. These towns, which had supported a mixed agriculture, with noria-based huertas, before the conquest, were converted into herding centers.[121]

A more complex pattern characterized the occupation of Murcia. There, the economy of the town's huerta and the cereal-producing lands, renowned in Islamic times, of the nearby Campo de Cartagena, was built upon shifting sand, namely the necessity of retaining a Muslim farming population more inclined to flee to Granada. Land, both irrigated and unirrigated, was deserted by the steady stream of migration, those fields farthest from the city being the first to be abandoned. If irrigated, they turned quickly to marsh. Nevertheless, the huerta continued to produce a variety of crops, from figs, cereals (wheat and barley, attested to by an abundance of mills located along irrigation canals), hemp and flax. In the Campo de Cartagena the Castilians had attempted to implant a [103] traditional wheat-growing regime, granting out parcels at año y vez. This attempt failed; as Muslims departed Christian rents fell and they too departed, leaving the area completely depopulated and used only for grazing. As happened in Andalusia, the spread of sheep raising was prodigious: it advanced at the expense of both cereal production and irrigation.[122]
In summarizing the Christian Spanish experience with irrigation, within the context of the issues raised by Wittfogel (see Section 4 of this chapter), I would stress again that the basic issues were cultural and economic, not institutional per se. Wherever the Christians learned Islamic techniques and used the surplus to support urban growth (e.g., in Valencia) continuity with the general structure of pre-conquest economy was total. Irrigation practiced in León and Castile did not produce the same results because the surplus was diverted to seignorial consumption. Nor was conquest necessary to effect a transition: the Catalans did it in Barcelona, initially by utilizing resources originally mobilized for water power, and later by the northward diffusion of noria technology. (123)

6. From Local to Transhumant Herding

The ordered landscape of al-Andalus, responding to an agrarian system tightly interlocked with an urban artisanal economy, had no place for the kind of rapacious, land-devouring pastoralism that later came to characterize the Mesta, whose herds ran rampant over many a settled community in the later middle ages and in early modern times. To a society of town-dwellers and agriculturalists the sheep was an animal primarily raised for meat; its wool was a byproduct. The Christians of the later middle ages turned the equation around: they cared only for wool and ascribed a low value to the meat. (124)

Little is known of the herding enterprise in al-Andalus. The Berber mountaineers were a herding people and practiced a largely pastoral economy. Al-Himyari notes the importance of sheep- and cow-rearing in the Sierra de Guadarrama, north of Toledo, whither meat buyers traveled to purchase livestock for distribution throughout the country. It can be assumed that the future Aragonese herding centers (Albarracín, Teruel, Daroca, Calatayud) comprising the former kūra of Santaver - a Berber stronghold - had been pastoral centers during the Islamic period. Farther west, the areas most in contact with Christian lands, such as Soria, were also areas of Berber settlement. Berbers were responsible for the introduction of the merino sheep (from Banû Marîn, a Moroccan tribe), but the first citations of merinos date from the fourteenth century, and no conclusion can be reached regarding their initial introduction. Several scholars have noted the similarity of Spanish and Berber sheep-handling procedures, as well as of the pastoral environments of places known to have been inhabited by Berbers. (125) Beyond these brief notes all is conjecture.

The settlement of Berber tribesmen in the mountains of the Middle and Upper Marches, together with the important role of herding in the economies of early Christian kingdoms, easily permits the characterization of frontier relations as a confrontation of herding peoples. This was certainly true of the Berbers' fleeting occupation of the mountains of Galicia, where they must have competed with indigenous mountaineers and Gothic refugees for summer pasture. For the Christians, the acquisition of pasture became a central motive for conquering Islamic territory. This is seen in the succession of regions called Extremadura, which has the meaning of the end of the route of transhumance; the early ninth-century Extremadura lay just to the south of the Duero (whence the false etymology associating such territory with far reaches of that river) in a no-man's-land certainly frequented by itinerant sheep drovers. Later, the search for pasture proved a continuing source of friction among Christian powers. The expansion of the Navarrese into Castilian lands in the eleventh century was in part a quest for new pasture, as was conflict between Castile and Aragón over the pastures of Soria, where the Castilian monastery of San Millán de la Cogolla finally obtained sufficient grazing lands for its ample herd in the early twelfth century. The pastures of Islamic Teruel were an incitement to Aragonese expansion. Once it was wrested from the Muslims (1170), the Aragonese were generally content to let the Catalans take the lead in further action against the enemy, although they were quick to occupy the ample grazing lands in the Valencian hinterland, leaving the irrigated lowlands for the Catalans. (126)

Whether the frontier was permeable to Christian or Muslim transhumant herders depends on the kind of transhumance practiced. In the west of the peninsula, the Islamic system was complete, with summer
pastures in the central cordillera and winter ones in the Guadiana basin. Muslim herders would have had no incentive to cross the Duero northward with their herds. The herders of the Duero Valley were faced with ever-diminishing space for grazing, as cereal and grape cultivation expanded. After the conquest of Toledo in 1085, vast new pastures were [105] opened to them. Klein suggested that Christians may have had access to southern pastures before 1085 through the payment of tolls and protection fees to Muslim authorities. (127)

In the west, therefore, since the Muslims had winter pastures aplenty, it would not have been to their advantage to open the frontier to Christian herdsmen, whose increasing desire to attain that pasture must have added to conflict along the border.

In the Upper March, however, the situation was quite different, inasmuch as that region constituted a natural transit range between the summer pastures of the Pyrenees and the winter pastures of Teruel and Murcia. The range structure would have constituted a natural inducement to permeability of the frontier, which would have been further enhanced by the high incidence of intermarriage among elite groups on either side (e.g., the relations of the Neo-Muslim Banû Qasî with various Pyrenean aristocratic houses).

In the twelfth century, with the decisive shift in the balance of power in the Christians' favor, there is no doubt that transhumance across the frontier was practiced throughout the peninsula. A variety of documents from Cuenca, Tudela, and Teruel attest that Christians were entering alAndalus with herds of sheep in the first half of the century, and a document of 1183 giving Christian herdsmen title to certain enclosed pastures was signed by the Muslim kings of Niebla and Murcia. In 1200 the bishop of Cuenca levied a tax on sheep being taken to "the land of the Moors" to be sold. (128)

The rise of transhumance in the Christian kingdoms was a result of the process of land clearance and cultivation just described. As more and more land was cleared for cereal production, vineyards, or orchards, less was available for the grazing of local herds. Moreover, as the extent of available pasture land diminished, the lay and ecclesiastical lords tended to fence off pasture previously open to villagers. The latter, using up common land in order to expand grain-producing fields, tended to become progressively excluded from the pastoral sector of the economy. When seignorial herds became transhumant, moreover, the villagers further suffered the loss of fertilizer, for these same herds had previously grazed on village fallow and stubble. Monasteries had maintained large herds from early times: that of San Román de Tobiellas (Castile) had 100 cows, 500 hogs, 24 oxen, 10 stallions, 80 mares, and 10 mules in 822, an early date. By the eleventh century, but before the conquest of Toledo, the herd of San Millán de la Cogolla was so large that it was able to [106] supply the royal palace with 600 sheep, 100 hogs, and 80 cows in 1049 without making a dent in the herd. The Cistercian monastery of Oya in Galicia also had a large herd, yet the Cistercians ate no meat. (129) Many monasteries, even before the commercialization of wool, appear to have used their herds as a kind of investment, frequently employing the animals in place of money -- the equivalence of 1 solidus, 1 sheep, and 1 modius of wheat was standard. To be sure, the monks used sheep for parchment and domestic wool, but these needs alone do not seem sufficient to explain the great size of monastic herds.

Transhumance, as indicated, was a response by large herd owners to the increasing pressure upon local pastureland. It was a system worked out by large proprietors which tended to exclude peasant cultivators from its inception. At base, it was a function of population density and the expansion of cultivated fields and therefore it did not emerge in full relief until the twelfth century, when Catalan monasteries, such as Santes Creus and Poblet, established summer pastures in Cerdaña, and when, after the capture of Toledo (1085), the Tajo Valley was opened to northern herds. The removal of this large animal population from its home base made possible the further expansion of grain and vine cultivation. (130)
The late eleventh and entire twelfth centuries witnessed the steady development of transhumant herding, involving the establishment of regular sheep routes (in effect, extended pastures called cañadas), a steady flow of royal grants permitting sheepowners to graze their flocks unrestrictedly throughout the realm, and exemptions from the payment of customs dues.(131) This movement culminated in Alfonso X's grant of 1284 establishing the Mesta, or organization of sheepowners, as the primary regulatory instrument of the pastoral economy. It was this moment that marked the rupture between the agrarian system of the early middle ages, involving a balance between local herding, cereal farming, and wine production, and that of the later middle ages, which emphasized commercial crops and initiated a long period of agrarian dysfunction.

7. Forests and Timber

Forests in the Mediterranean world are inherently unstable. Once cut down, they regenerate only with difficulty. Under the most favorable of conditions, hardwood forests, when cut down, will be replaced by a secondary growth of pines, or scrub. If sheep and goats are grazed on the stubble, conversion to a steppe-like vegetation cover is assured. The precariousness of the forest and, hence, of wood supply, imposed natural constraints upon the diffusion of wood-utilizing technologies; accounted for local shortages wherever such technologies were practiced; and imposed characteristic trading patterns (second only to wheat in its tyranny over trade routes) both within the Mediterranean basin and between it and the forested north.

In comparing the eastern and western Islamic worlds, Maurice Lombard distinguished between deforestation (déboisement), characteristic of the former, and clearance (défrichement), typical of the latter.(132) The same distinction can be applied to the Iberian peninsula, where the possibilities of regeneration of timber decreases from north to south. The progress of clearance, however, linked to agricultural and industrial development, began first in the south and only became a problem in the Christian kingdoms well after A.D. 1000, when the settlement of the plains was in full swing.

In antiquity, deforestation was mainly the result of mining and shipbuilding, the industries that made the greatest demand upon wood supply. In Spain, this affected only the forests of eastern Baetica, particularly the area around Almería, which, in Islamic times, was the site of an arsenal that had to be supplied either from inland stands or, by ship, from the Moroccan Rif. Otherwise the peninsula was still densely forested. Pines were found in the Algarve and Murcia in the south, in the mountains of Cuenca and Albarracin, in the hinterland of Tortosa, and on the island of Ibiza. The Aljarafe area of Seville was famous for acacias. Oaks were found in vast areas of Andalusia, notably at Fahs al-Ballût ("Plain of the Acorns," now Los Pedroches), a vast stand of evergreen oaks extending across mountains and high plateaux to Almadén. Oaks were also found in Algarve, Extremadura, and New Castile. To the south of the Duero lay another great sash of oak, respected by the Muslims as a strategic barrier, and the entire northern meseta was rich in kermes, evergreen, and holm oaks. The cork oak was also widely diffused, in the south of Old Castile and in al-Andalus.(133)

The demands made upon timber supply by the rapid urbanization of al-Andalus (house construction, furniture, industrial fuel), by intensification of agriculture (hydraulic wheels), and by the rise of the Umayyad state to hegemony in the western Mediterranean (naval supplies) resulted in a retreat of forests from high-demand areas, the growth of wood-related industries in remote mountain villages, and the establishment of bonds of economic interdependence with the North African coastal region. The area around Almería, where 'Abd al-Rahmán II established an arsenal, was supplied from the Moroccan Rif, from pine stands in the interior of the Betic cordillera, from the Balearics and from the eastern coast, where logs were floated down the Júcar and other rivers to Cullera. Entire villages in the mountains of Segura, Cazorla, and Alcaraz supported themselves by exporting wooden vessels and utensils to urban centers. The same was true of a number of places in the Algarve. Yet al-Andalus was
well enough supplied with this resource to be a major exporter of wood in the Islamic world, shipping both timber and finished products from the east and west coasts to Morocco, from which (particularly the port of Qasr al-Saghîr) timber was also imported.\(^{(134)}\)

In the Christian kingdoms, forests were cleared mainly for cultivation. Early settlements on the frontier were made in natural clearings and in places where the population density was light, as on the plain of Bages as late as the eleventh century, the attack on the forests was marginal in spite of the increasing pace of settlement. Royal charters were both generous in granting rights to villagers to cut wood (for fuel and for building houses) and to shepherds to cut branches for the making of corrals, fences, and other needs related to herding. But by the twelfth century, with increasing pressure upon woodland, a revaluation of the resource took place, a change in consciousness brought about by compelling economic interests. As supplies dwindled, wood became, as it had long before in the Islamic world, an object of commercialization. There was a natural current of exchange between plains and mountains, the latter supplying carts, wooden agricultural implements, and barrel staves (the charters record the frequent inclusion of \textit{toneles} and \textit{cubos} -- wine casks in various exchanges), in return for grain. In the Galician documents studied by Pallares and Portela the first sale of wooden products for money occurs in 1199, with mentions increasing thereafter as cultivators sought wooden containers for wheat and wine, as well as chestnut or oaken stakes for grapevines.\(^{(135)}\)

Not unnaturally, as wood became more valued, lords sought to protect their own sources by making them off-limits to the peasantry (by creating \textit{defesas}, or preserves). Conservation has always begun typically as the strategy of an elite group to conserve a vital economic interest. The monastery of Cardeña had a \textit{defesa lignorum} as early as the tenth century; \(^{[109]}\) the eleventh-century Fuero of Nájera forbade the cutting of wood in the town forest; restrictions on the communal use of forests became generalized, and by the thirteenth century alarm was widespread. Alfonso X, in the \textit{Siete Parti'das}, piously warns against those who cut down trees with "bad intention," alluding to the "great pleasure and comfort" that these afford to men when they behold them. In view of the fact that burning off of woodland was a common method of clearance used by peasants as well as by herdsmen, who believed that the ash enhanced the fertility of pasture, the Cortes of Jérez decreed in 1268 that "he who sets fire to a forest is to be thrown into it."\(^{(136)}\) It is probable that aristocratic concern was able, at the expense of social justice, to ward off extensive deforestation for several hundred years, postponing the price that the Islamic world began to pay in the eleventh century.

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\textbf{Notes for Chapter 2}


20. See Maravall's critique of the received view: *Concepto de España*, pp. 139-154.


26. *Poema de Fernán González*, p. 66, stanza 222. The ratio implied of 45,000 Castilian-Leonese to around seven million Andalusis might not be far of the mark as a judgment retrospective to the tenth century.


28. Ibid., p. 388: *terram de ursorum et aprorum*.


31. On the shift from fear to security as a function of increased population density, see Maravall, *Concepto de España*, pp. 272-276.

32. Pérès, *Poésie andalouse*, p. 188.


40. Ibid., p. 65, and, following Bolens, Watson, "Arab Agricultural Revolution." Note that García de Cortúzar, *Época medieval*, pp. 80-81, dates the intensification of huerta economies to the period 925-1008 as a result of urban demand during the Caliphate.

41. Robert Hunt, personal communication.

42. See Lombard, *Espaces et réseaux*, p. 63.

43. On surviving Arabic documentation on irrigation in al-Andalus, see, for example, Angel González Palencia, "Notas sobre el régimen de riegos de Veruela en los siglos XII y XIII," *Al-Andalus*, 10 (1945), 79-88; José María Cueco Adrián, *La Font de la Vall de Segó* (Valencia: Publicaciones del

44. The Valencian system is easily accommodated to the 144-unit model; see *ibid.*, pp. 211-213.

45. *See discussion in ibid.*, p. 214, and references.


47. Guichard, "Peuplement de la région de Valencia," p. 125. Lévi-Provençal inexplicably associated this sâqiyat Hawwâra with the Mislata canal, which is on the opposite side of the river; "La toma de Valencia por el Cid," *Al-Andalus*, 13 (1948), 147. My derivation of Favara from Arabic fawwâra, "spring" (*Irrigation and Society in Medieval Valencia*, p. 228), is erroneous.


55. Watson, "Arab Agricultural Revolution," pp. 11, 14; Bolens, "L'Eau et l'irrigation."


72. Thus *presa* is typically found in the meaning of diversion dam, rather than the Arabism *azud*; *recum* or *aqueductum* for canal, instead of *acequia*. For examples in documents of the tenth and eleventh centuries, see Rodríguez Fernández, *Monasterio de Ardón*, pp. 221, 234, 253, and Maria del

74. See R. Brunschvig, "Ba'l," EI², I: 968-969; and al-Máwardi, Statuts gouvernementaux, especially p. 314. Máwardi distinguishes between land watered only by precipitation (‘idhy) and that watered only by the humidity retained in the soil (ba’l); the usual distinction was more broadly cast.

75. Makki, Aportaciones orientales, p. 164.

76. García de Cortázar, Epoca medieval, p. 75.

77. García de Cortázar, San Millán de la Cogolla, p. 247, sums up this series of changes admirably.


79. García de Cortázar, San Millán de la Cogolla, pp. 84-85.

80. García Fernández, "Campos abiertos y campos cercados," p. 125; García de Cortázar, Epoca medieval, p. 207; La reconquista española y la repoblación del pais (Zaragoza: Consejo Superior de Investigaciones Científicas, 1951), p. 190; Lynn H. Nelson, "Land Use in Early Aragón: The Organization of a Medieval Society," Societas, 3 (1973), 123. Note Nelson's conclusion (p. 126) that dispersion of settlement in the mountains was a response not to population pressure but to a competitive economic situation where each nucleus of settlement had to ensure as much production of winter fodder as possible.


82. Sánchez-Albornoz, Despoblación y repoblación del valle del Duero, p. 298; García de Cortázar, San Millán de la Cogolla, p. 104; Rodríguez Fernández, Monasterio de Ardón, p. 215 (document of 952). On new roads, see García de Cortázar, op.cit., p. 151. For citation of a vineyard located on a new road (vinea super viam novam) indicative of the monastery's need to transport its grape harvest, see Luciano Serrano, Cartulario de San Millán de la Cogolla (Madrid: Centro de Estudios Históricos, 1930), p. 98.


84. Sánchez-Albornoz, Despoblación y repoblación del valle del Duero, pp. 183 (drought), 243 (perambulations, e.g., illo monte, illa aqua, illa lonte, per illos collos, etc.).

85. Ibid., pp. 125, 215, 259; R. Menéndez Pidal, "Repoplación y tradición de la cuenca del Duero," xxx; García de Cortázar, San Millán de la Cogolla, P. 102, and idem, Epoca medieval, pp. 136, 149.

86. Sánchez-Albornoz, "Repoplación del reino asturleonés," pp. 236, 262 n. 5; Reyna Pastor de Togneri, Conflictos sociales y estancamiento económico en la España medieval (Barcelona: Ariel, 1973), p. 186; Moreta, San Pedro de Cardeña, pp. 34, 35, 40, 60; García de Cortázar, San Millán de la Cogolla, p. 133.

87. See de la Concha, Presura, passim, but especially pp. 119, 123, 137; and La reconquista española y
la repoblación del país, p. 212.


103. See García de Cortázar, *San Millán de la Cogalla*, pp. 93, 290-291, 294, and *idem, Epoca medieval*, pp. 231, 240.


111. Tomás Muñoz y Romero, *Colección de fueros municipales y cartas pueblas* (Madrid: Alonso, 1847), p. 339: *Et ubicumque potuerint invenire aquas per rigare pecas, et vineas, sive per molinos, vel ad ortos, sive ubicumque opus habuerint, accipient eas.* Although I agree with Jesús Lalinde Abadia that the public character of water inherited from Roman law tended to become increasingly eroded, leading in the later middle ages to a pronounced trend towards privatization and patrimonialization, I cannot follow his argument that water when included as an appurtenance to private property remained, in the period here under consideration, essentially public (to enhance settlement), even though it was often the object of patrimonialization; "La consideración jurídica de las aguas en el derecho medieval hispánico," *Anales de la Universidad de la Laguna. Facultad de Derecho*, 6 (1968-1969), 43-93, especially p. 50.

112. Armando Repesa, "Evolución urbana de León en los siglos XI-XIII," *Archivos Leoneses*, 23 (1969), 267 n. 64; Sánchez-Albornoz, "Repoblación del reino asturleonés," pp. 281 n. 12, 295 n. 46; Rodríguez Fernández, *Monasterio de Ardón*, p. 96 (in this latter case the point was moot, because it was shown that the downstream mill did not, in fact, prejudice the monks' rights; if it had there is no doubt that the monastery would have prevailed).


117. On the Ebro, *La reconquista española y la repoblación del país*, p. 67; on Valencia, Glick, *Irrigation and Society in Medieval Valencia*, p. 231; on Aragonese settlement policy and comparison


120. Reyna Pastor, "Poblamiento, frontera y estructura agraria en Castilla la Nueva (1085-1230)," *Cuadernos de Historia de España*, 47-48 (1968), 171-220.


123. See below, p. 349 n. 43.


126. According to L. P. Harvey, Extremadura is not related to the Duero River but is derived from estremarse, to be separated off, to be sent on a transhumant migration (a meaning common both to Castilian and to Catalan), yielding the particle stem estremad-, which, with the suffix -ura added, gives the sense of "place to which cattle and sheep are sent on transhumance" (personal communication). On pastoral politics, see García de Cortázar, *Epoca medieval*, p. 235; *idem*, *San Millán de la Cogolla*, pp. 263, 265, 302; Nelson, "Land Use in Early Aragón," p. 127; and Klein, *Mesta*, pp. 32, 150.

127. Klein, *Mesta*, pp. 167-168. For this discussion of the permeability of the frontier by herders, I have relied upon an invaluable discussion with Professor Lynn Nelson.

128. Klein, *Mesta*, pp. 166 n. 2; 309 n. 3.


