CHAPTER 5

STAPLE PRODUCTION, CULTIVATION AND SEDENTARY LIFE: MODEL INPUT DATA

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The construction of a computer model of an ancient community from the 'ground up' requires a wide range of input data relating specifically to the basic processes of everyday life as well as to the behaviors of the individual agents. Factors such as the variation in the size of households and their component families, the agricultural calendar that regulated much of everyday life, additional food requirements for feast days, weddings, etc., the components of a pastoral economy, sources of fuel and so on all need to be represented, ideally in a quantitative way. Because no data source is complete, this information must come from a wide range of sources, which include cuneiform texts and other historical documents, ethnoarchaeology, technical consultants' reports, and from archaeological, archaeobotanical, environmental and other landscape data (Table 5.1; see also Hunt 1991). As noted by Francis Reynolds, food and drink in any society depend to a significant degree on social context, and as she states: 'There is a profound difference between eating and drinking solely to sustain life and doing so with the aim of enhanced pleasure, in other words, between functional consumption and gastronomy' (2007: 173). Due to the focus of our modeling efforts, this chapter is primarily concerned with sustainability of the masses and functional consumption in general, while the gastronomic pleasures of ancient kings and the elite are only treated cursorily.

An extensive range of ethnographies (e.g., Russell 1988; Sweet 1974) and consultants' reports produced for various development projects in the Middle East (e.g., Dowson 1921a and 1921b) provide a wide range of accessible data sources. In addition, limited demographic data are available for the site of Kish in modern Iraq, as well as from Dinka Tepe and Hasanlu in Iran (Rathbun 1982, 1984); more extensive mortality data from the Roman period have enabled life tables to be constructed (Saller 1991), thereby providing a crucial source for the demographic profile of the community.

The Mesopotamian cuneiform record provides a unique source of evidence for the model and has played an extremely important role in the formulation of our agent-based and household-based model, both at a general theoretical level (see Schloen 2001) and at a more detailed one, as they have provided numerous details on everyday life and eating habits. These texts provide a wide range of specific ancient data that would be difficult to obtain with an equivalent level of detail and/or reliability through studies of archaeological or ethnographic material alone. Ideally, such sources should derive specifically from the site and area being modeled. Although we are fortunate to have some valuable texts from the site of Tell Beydar (see Chapter 4), in order to get the most use out of the available sources it is necessary to extrapolate from a wider geographical region, as well as from a broader time range than the third millennium BC.

A significant part of the Mesopotamian economy was based on agriculture, and the cuneiform texts supply detailed information on practically every aspect of agricultural production. Whereas the late third millennium BC in southern Mesopotamia has produced a substantial corpus of textual data on agriculture, the contemporary textual evidence from Upper Mesopotamia and the dry-farming regions of the Near East remains scarce. Nevertheless, private and royal archives exist for the city of Nuzi of the kingdom of Arraphe near modern Kirkuk, which can be dated to the middle of the second millennium BC (Pedersén 1998: 15-29). The (approximately) 5,000 tablets from Nuzi offer an exceptional wealth of information concerning real estate, fields, and agricultural matters for a period of roughly 85 years. In addition, a smaller, earlier archive of some 200 tablets from the Akkadian period (ca. 2350-2150 BC) has been found at the same site (Gasur).

For southern Mesopotamia, the most comprehensive description of agricultural procedures from ancient Mesopotamia are the 'Farmer's Instructions' (Civil 1994). The 111-line text, tentatively dated to the eighteenth century BC, or slightly earlier, can be seen as a manual laying out the fundamental rules of cereal cultivation over the course of an entire year. It has provided an overall framework for our modeling of agricultural tasks, specifically irrigation, plowing, harrowing, sowing, harvesting, threshing, and winnowing. The outline for our model of the agricultural calendar has been complemented and revised using other

Table 5.1 Source and class of input data to the ENKIMDU models.

Class	Sub-class	Source					
		Cuneiform texts	Other historical texts	Ethnographic data	Consultants' reports	Archaeology	Environmental & landscape data
Consumption	Cereals	■		■		■	
	Caloric needs				■		
	Feasts	■				■	
	Building materials (chaff, wood)			■		■	
	Fuel needs			■	■	■	
Demography	Mortality		■	■	■	■	
	Family size	■	■	■	■	■	
	Marriage & inheritance	■		■		■	
Agriculture	Crops grown	■	■	■	■	■	
	Agricultural area				■		■
	Fallow	■	■	■	■		
	Plough animals	■	■	■		■	
	Seeding rates	■		■			
	Agricultural calendar	■		■	■		
	Field shape, size	■		■			■
	Land ownership	■	■	■	■		
	Labor input	■	■	■	■		
	Soils data				■		■
Pastoral economy	Flock size	■		■	■		
	Livestock density				■		
	Fodder needs	■	■	■	■	■	
	Pastoral lands				■		■
Secondary products		■		■	■	■	
External factors	Trade exchange, tribute	■				■	
	Pestilence, locusts	■	■				
	Climate data				■		■
	Droughts	■	■				■
Control	Crop yields	■	■	■	■		

textual sources, in particular the tens of thousands of published administrative and economic tablets from the second half of the third millennium, which provide detailed information on specific issues crucial to our modeling work. When these economic texts, which predominantly concern agricultural matters, are studied together in homogeneous series, they offer details on most aspects of ancient Mesopotamian agriculture.

As an example of such a homogeneous series, a group of about seventy cadastral texts from the province of Lagash in southern Mesopotamia dated to the Ur III period (ca. 2112-2004 BC)[1] provide evidence on land measurements and boundaries (Liverani 1990:155). These so-called 'round tablets' describe the agricultural landscape of the alluvial plain and provide the orientation, size, and shape of the individual fields cultivated in the province (Liverani 1990, 1996; Maekawa 1992). Moreover, many of these 'round tablets' also provide significant data on the expected yields of the fields in question. According to Maekawa (1974: 26), the average yield in the seventh year of the reign of the Ur III king Amar-Suen was 31 *gur* and 244 *sila*$_3$ barley per *bur*$_3$ land (= 932kg/ha), and 25 *gur* and 11 *sila*$_3$ per *bur*$_3$ (= 733kg/ha) in the following year.[2] Such high yields compare favorably with the average barley yields of 1,396kg ± 67.5 per hectare on irrigated fields cultivated with primarily primitive agricultural technologies in the Diyala region in the 1950s (Adams 1965: 17). Depending on the seeding rates, the Ur III yield rates would equal an average productivity of some fifteen to twenty times the seed volume used on the fields (Liverani 1990-1991: 365; Maekawa 1974: 27). Such impressive productivity rates are easier to accept if we take into account that the farmers in southern Mesopotamia were planting their fields by means of drilling the seeds into the furrows with a so-called seeder plow (*apin*) pulled by oxen, a technique that reduces the amount of seed grain by half compared to broadcast sowing (Halstead 1995: 14). Naturally, this technique left its mark on the agricultural landscape of the south. The fields described in the 'round tablets' were very large, with the majority being in the range of 100-125 *iku*, or 35-44ha (Liverani 1996: figure 2), with the standard seemingly being 6 *bur*$_3$ (108 *iku*), which would equal roughly 38ha (Maekawa 1992: 408). As discussed in Chapter 4, these fields, which were organized in a regular pattern of narrow and elongated strips of land, constitute a clear indication of the institutional character of cereal production in southern Mesopotamia (Liverani 1996: 8-10; Maekawa 1992: 407).[3] Although long and narrow fields are more suitable for plowing with oxen and a seeder plow because elongated fields reduce the number of turns necessary for the plowing teams to make (Liverani 1990: 171), the main reason for the shape and size of these fields relates to the nature of the irrigation system (so-called 'furrow irrigation') that prevailed in the extremely flat alluvial plain of southern Mesopotamia (Chapter 4). Further to the north, but well within the zone of irrigated agriculture, the fields of Mesopotamia take a more irregular and less elongated form (see Liverani 1996, 1997).

Overall, data from cuneiform texts, although skewed towards the official economy rather than the everyday village-based agricultural production, provide a valuable source of information, which enables a sensitive and often quantitative comparison to be made between the irrigated south and the rain-fed north. However, not all of these data can be harnessed as input for the model; some must act instead as a control for model output. Hence, the copious records of crop yields can be employed as a cross-check on the output generated from the U.S. Department of Agriculture's Soil and Water Assessment Tool (SWAT) model, thereby enabling us to gain an idea of the realism of the modeling (Chapter 10).

Thus, ethnographic studies, archaeobotanical remains, and cuneiform texts together form a rich set of complementary data, aiding the identification not only of the staple crops of Bronze Age Mesopotamia but also the steps involved in cultivating and processing them. Lexical texts appear to contain most, if not all, of the species grown, not only of cereals but of pulses and oil plants as well (Tablet XXIV of the canonical series *ur*$_5$*-ra* = *ḫubullu*). Archaeobotany indicates that some thirty 'distinct operations' were 'involved in growing any one type of cereal crop and converting it to food' (Hillman 1984: 114),[4] and while these operations were similar in the north and south they differed in fundamental ways, namely in a) the use of hydraulic cultivation, b) the social and economic organization of the cultivators, c) the specific cultivars, and d) their relative proportions. The following section identifies the main crops grown in Bronze Age Mesopotamia and outlines the data relevant to modeling their cultivation; a brief overview of other, non-agricultural staple goods is offered as well, for both the north and south.

For agricultural production, we adopt the nomenclature offered by Postgate (1984a: 97), which includes the following definitions:

- sowing-rate: the volume of seed sown per unit area
- yield-ratio: the ratio of volume of grain sown in a given area to the volume of grain harvested from the same area
- harvest: the volume of grain actually *harvested* on a given area
- area-yield: the volume of grain harvested per unit area (whether an actual or expected yield)

[1] Most of the tablets can be dated to the seventh and eighth years of king Amar-Suen's reign.

[2] All calculations assume that 1 *iku* (1/18 *bur*$_3$) equals 3,528m^2, 1 *sila*$_3$ in southern Mesopotamia (1/300 *gur*) equals 1 liter, and 1 liter barley equals .62kg.

[3] Obviously, the 'round tablets' were drawn up within the 'public sector' of the society and it is not surprising that the fields in these texts belonged to the same public or official part of the economy. The organization of private fields–if they existed–remains uncertain.

[4] Such operations are also described in detail in various ancient texts, the most comprehensive and detailed one being the Sumerian agricultural manual referred to as 'The Farmer's Instructions' (see Civil 1994).

STAPLE PRODUCTION IN THE NORTH

From the mid- to late fourth millennium, at least five cereal crops were cultivated in northern Mesopotamia: two-row hulled barley, free-threshing wheat, glume wheat, lentil and common pea (Charles & Bogaard 2001), a range that suggests a fairly broad based and non-marginal agricultural economy throughout much of the third millennium BC. Staple production and crop proportions in the earliest history of northern Mesopotamia can primarily be reconstructed from anthracological data collected from archaeological sites in the region and from information derived from a rather limited number of cuneiform texts. The identification of stable crops in the cuneiform material is complicated by the fact that the Sumerian term for barley (*Hordeum vulgare*), by far the most common staple crop in southern Mesopotamia, was also used as a collective term for grain in general; therefore, at least under some circumstances, it also could include references to other crops such as 'einkorn' wheat (*Triticum monococcum*) and emmer (*Triticum dicoccum*) (see e.g., Hrozny 1913: 96). One pre-Sargonic text dating to the middle of the third millennium, from what appears to the be the central archive of Tell Beydar located in the Upper Khabur basin in northern Syria, may help us in establishing the proportions of cultivated stable crops in this area. Assuming that our interpretation of this text is correct (see Widell 2003: 725-26), this text would indicate that roughly two-thirds (68.5%) of the Tell Beydar fields were cultivated with barley, while the remaining third (31.5%) of the land was divided up equally between wheat and emmer cultivations.

Such figures correspond well to recent anthracological studies at Tell Brak, located some 45 km to the east of Tell Beydar. According to Sue Colledge (2003: 394-396), the carbonized plant remains recovered at Tell Brak demonstrate very clear chronological trends in the composition of cereal taxa, where both emmer and wheat decrease with time while barley and fresh-threshing wheat chaff are more common in samples of later phases. The data appears to indicate a shift away from a predominance of wheat and emmer during the early fourth millennium towards a predominance of barley in the later third and early second millennia.

Unfortunately, there are no cuneiform texts from northern Syria that can assist in reconstructing regional crop proportions in the second millennium. However, barley was certainly the most frequently mentioned cereal in the early second millennium texts from ancient Mari (in eastern Syria near the Iraqi border), and barley is considered to have been the main crop in the city's institutional agricultural production (Dalley 1984: 83-84; van Koppen 2001: 482). Further to the east, in the kingdom of Arappha in northern Iraq, texts from the city of Nuzi dating to the middle of the second millennium offer a similar picture, with a ratio of 4.5:1 between barley and emmer plus wheat (Zaccagnini 1975: 217).

The farmers in Nuzi appear to have relied only on broadcast sowing and the regular plow *majāru* without the seeding funnel (Widell 2005a). Consequently, we have to assume that seeding rates were significantly higher there than in the south, where the ancient farmers planted their fields using the seeder plow (see below). In the Akkadian period, the standard seeding rate is recorded to have been 60 northern[5] *sila*$_3$ barley per *iku* of field, or ca. 87kg/ha (Zaccagnini 1979a: 854f.). This rate is roughly twice as high as that for irrigated fields in southern Mesopotamia during the Ur III period, and Zaccagnini has argued that the Akkadian *iku* in Gasur, in all likelihood, was significantly larger than the *iku* in southern Mesopotamia (1979a: 856). However, all other data on seeding rates come from fields where the seeder plow was employed. If we assume that the region of Gasur received similar annual rainfall in the Akkadian period as it does today (ca. 400mm), 87kg/ha is a realistic sowing-rate for broadcast sowing in the region. A single text from Gasur lists the unitary barley yields from different fields (Zaccagnini 1979a: 855) as ranging from 592 to 666kg/ha, indicating a seed:yield ratio of approximately 1:7. The system of measuring surface areas used in later texts from Nuzi is less clear (Zaccagnini 1979a), and any absolute numbers of seed rates and/or yields remain uncertain. Nevertheless, the relative proportions between seeding rates and the yields recorded in Nuzi, which range from 1:8 to 1:1 with the majority of the attestations in the order of 1:5-7 (Zaccagnini 1975), seem to fit the ratio recorded in Gasur rather well.

While some fields in the texts from Nuzi were also irrigated (šaqû), it is generally accepted that 80-90% of the fields relied exclusively on rainfall (Zaccagnini 1979b: 107-113). The shapes and sizes of the fields in Nuzi are uncertain, but the majority were significantly smaller than the fields in the province of Lagash in southern Mesopotamia (Zaccagnini 1979b:77). Moreover, while some 98% of the Ur III Lagash fields were devoted to barley (Maekawa 1974:41), only 80% of the Nuzi fields were used for this cereal, the remaining fields being used for emmer and wheat (Zaccagnini 1975: 192-193 & 217). In addition to fields planted with barley and to some degree wheat and emmer, palm groves, generally located close to the settlements and with direct access to water for irrigation, were a common feature in the agricultural landscape of the central and northern parts of Babylonia and the southern reaches of Syria, and dates remained an important agricultural staple in much of Mesopotamia throughout antiquity. In addition to dates, which were harvested in the early autumn in the north and therefore complemented the harvest of field crops that took place in the spring, the northern gardens, just like their southern counterparts (see below), were used for the inter-plantation of fruit trees, including fig, pomegranate and medlar, as well as a variety of vegetables (Wiseman 1983: 142). Other important crops included the olive, which was widely cultivated in the Early Bronze Age in regions such as Syria, Anatolia and upper Mesopotamia in

[5] Note that this measurement corresponded to approximately 0.84 liter in northern Mesopotamia.

general, but was never able to endure the climate and soil conditions of the southern alluvial plain (Kaniewski *et al.* 2012; Malul 1996). The first evidence for wine production from grapes appears as early as the mid-sixth millennium BC, and by the Early Bronze Age the acclimatization and domestication of vine, which certainly was not native to the alluvial plain of southern Mesopotamia, was widespread throughout the region (Zettler & Miller 1995; Miller 2008; Powell 1995: 100f.).

CEREAL CROPS IN THE SOUTH AND THE AGRICULTURAL CYCLE

Aside from the necessary labor and organization, the primary factors involved in agricultural production in the south are soil quality and control of the water supply. Given the absence of any appreciable rainfall in the south, settlements rely on hydraulic cultivation, which imparts a high level of control over the water supply and thereby crop response. The distinct ecology of the south determines the specific staple crops that can be grown; the availability of the water supply in relation to their specific requirements and maturation periods of crops determines the cycle of their cultivation. With the Tigris peaking in April-May (with its lowest discharge in September-October) and the Euphrates peaking in April (with its lowest discharge in September-October), most cultivation takes place during the winter. The basics of crop cultivation in the south during the Bronze Age have been summarized in the *Bulletin on Sumerian Agriculture* and by Potts (1997: 56-90), among others; details on the agricultural cycle and soil preparation are available in such sources as *The Farmer's Instructions* (Civil 1994).

The identifications of the principal cereal crops in the south are relatively secure. From the earliest documents available, barley (*Hordeum*) and wheat (*Triticum*) – in the form of emmer and a second type of wheat – were the principal crops, followed, perhaps, by millets (*Panicum*) and oats (*Avena*) (Powell 1984: 49; Charles 1984: 17). The importance of barley and wheat is clear in the native nomenclature: in literary texts, these two form the 'major crops' and all others form the 'minor' (lit. 'small') crops (Stol 1985b: 127; cf. Maekawa 1984: 81). Even in recent times, barley and wheat make up some 89% of the total acreage of field crops in Iraq (Buringh 1960: 69).

Barley (*Hordeum*)

Species of barley (*Hordeum*) are divided by the number of rows of grain (either two or six) produced per stalk and by whether its grains are naked or hulled, the latter indicating that the grain itself is protected by a floret that, after threshing, requires additional parching and pounding to be removed (Charles 1984; van Zeist 1984). Hulled, six-row barley (*Hordeum sativum*, var. *vulgare* or *hexastichum*) is the most common form in the south based on archaeobotanical evidence (Charles 1984: 27; Potts 1997: 58-59); according to Hillman, there is no evidence for naked barley (*Hordeum nudum*) from sites in Mesopotamia (1985: 5; citing Renfrew 1984). The traditional explanation for barley's prominence is its high salt tolerance, even though its rate of evapo-transpiration actually increases soil salinity over time (Potts 1997: 60). Its higher area-yield compared to wheat may better account for this phenomenon (Powell 1985).

The identification of barley as the principal crop in Bronze Age southern Mesopotamia goes back to Hrozny (1913) and is unchallenged today. In terms of acreage and economic importance, barley (Sum. *še,* Akk. *še'um* or *uṭṭetum*) dominated other crops by several orders of magnitude. In one year of the Ur III period, barley accounted for some 98% of the cereal crop in the area of Girsu (Maekawa 1984: 81). Indeed, as in the north (i.e., Upper Mesopotamia), the word for barley was routinely used as the more general 'grain' in the textual record.

Wheat (*Triticum*)

Wheat falls into two basic categories, glume wheats or free-threshing wheats, categorized depending on the process(es) necessary to remove the grain. Glume wheat is so called because the grains are enclosed by the glume and only the spikelets are removed during threshing. As with hulled barley, freeing the grain requires the additional step of pounding, usually along with parching (Charles 1984: 24-25 & fig. 4; van Zeist 1984: 9). In free-threshing wheats, the grains are only loosely held in the spikelet, to the point of being visible in ripe ears.

Alongside barley, domesticated emmer (*Triticum dicoccum*; Sum. *ziz*$_2$, Akk. *ziz(z)um*), a glume wheat, was the other 'major' crop cultivated in the south. Several types of *ziz*$_2$ are attested in the textual record, many of them dealing more with preparation than with different species; of particular interest here are *ziz*$_2$ alone, which represents the unprocessed form (i.e., the threshed, cleaned spikelets), and *ziz*$_2$*-an*, Akk. *kunāšu*, which represents the processed form (i.e., the kernels after being separated from the chaff). The word *kunāšu* was used for the processed form until at least the Old Babylonian period, when the latter came to describe both processed and unprocessed emmer (Powell 1984: 51). Emmer is highly resistant to drought and well suited to making bread and beer (Charles 1984: 25); processed emmer is used for groats, beer, and soup (see Chapter 6).

Along with emmer, another type of wheat was also grown in the south (Sum. *gig*, Akk. *kibtum*). This was likely a free-threshing wheat, and, of the varieties known, *Triticum durum* seems to be the most likely candidate: 'On well-irrigated, rich, fertile soil of the type that can occur in Southern Mesopotamia (and presumably did in the Sumerian period), *T. durum* can give higher yields than any of the glume wheats in the hot, dry conditions prevalent there. Its flour is weak and unless mixed with the stronger flour of, say, *T. aestivum* is not suitable for bread-making' (Charles 1984: 26). But *gig*/*kibtum* may also be identified with *Triticum aestivum* or with club wheat (*Triticum compactum*), both of which are attested in the south in the Bronze Age (Renfrew 1984: 35). The former thrives in Iraq in low salinity and irrigation and has yields corresponding to those found in cuneiform records (see below); it also makes a flour that is ideal for bread.

Another type of wheat mentioned in the textual record (Sum. *gu*$_2$ *nida*) may have been 'naked emmer,' a free-threshing wheat.

Millet

Millet (*Panicum milaceum*; perhaps Sum. *ar-zig*, Akk. *arsikku*) is the only summer cereal crop attested for the south in the third millennium. It is a very drought-resistant plant that produces high yields and oil-rich seeds for breads and cakes.

The Agricultural Cycle and Quantitative Data

The agricultural cycle in southern Mesopotamia was dictated primarily by the availability of water and the specific needs of the cereal crops for maturation. As noted above, the primary cereals cultivated were winter crops, which were sown in the fall and harvested in the spring during the peak flood season, when water was readily available for irrigating in the final months of ripening.

The agricultural calendar of Bronze Age southern Mesopotamia was first worked out by Landsberger (1949) and has since been studied in detail by Hruška (1990), LaPlaca and Powell (1990), and especially Civil (1994), who compiled invaluable quantitative data from Ur III records. Much of this evidence has been summarized by Potts (1997: 74). For winter cereals, this information can be summarized (Table 5.2)

These steps are treated in detail below; some of the tools associated with each step in modern Turkish villages were presented by Hillman (1984: 144-145).

Soil Preparation and Sowing

Early Flooding

Preparing a field for irrigation often started with an initial flooding, which moistened the soil for subsequent work. Tilling with the hoe before the initial plowing was not necessary; however, doing so allowed for better aeration in the soil, ultimately leading to increased yields (Hillman 1984: 116). With the hoe, tilling rates of 54-720m^2 per day are attested, the average being 195m^2 per day per person (see, e.g., Civil 1994: 79).

Manuring

Textual material confirms that some level of manuring with cattle and sheep dung took place in southern Mesopotamia (Butz 1979: 305-309). This manuring appears to have been associated with foraging and plowing, and, as in the north, manure could be brought by humans to the fields in baskets, pots, or vehicles such as wheeled carts, then

Table 5.2 The agricultural cycle for the winter cereal crops in the south (based on Potts 1997: 74 Table III.1, following Hruška 1990 and Civil 1994)

Month (1)	Cultivated Land	Fallow land
i (April)	last irrigation; early (barley) harvest; stacking sheaves	leaching
ii (May)	(barley and wheat) harvest; threshing	surveying of wet fields
iii (June)	harvest; stacking sheaves; threshing; initial plowing	-
iv (July)	harvest; transport and storage of grain; initial plowing; harrowing; sealing grain silos	inactivity
v (August)	end harvest; early hoeing; early weeding; harrowing; sealing grain silos	inactivity
vi (September)	early plowing and sowing (barley, then wheat); hoeing; weeding; harrowing	inactivity
vii (October)	plowing and sowing (barley and wheat); hoeing; weeding; harrowing; breaking clods	inactivity
viii (November)	late sowing (barley and wheat); end plowing; hoeing; end weeding; removing clods from furrows	inactivity
ix (December)	late sowing (barley and wheat); late hoeing	inactivity
x (January)	inactivity; end sowing; late hoeing; irrigation	preparation of fields
xi (February)	first seedlings; irrigation	preparation of fields
xii (March)	irrigation; early harvest	inactivity

Note: Correspondences between ancient and Gregorian months are approximate.

spread with the appropriate tools. Manuring could happen at various stages, even before plowing to allow the fertilizer to penetrate the soil as much as possible. In addition to animal dung, it is very likely that Mesopotamian farmers increased soil productivity through the distribution of other animal by-products, such as bone and horn meal; through green manuring and the planting of legumes; and through the natural distribution of nitrates by allowing sheep to graze and trample in the agricultural fields (see Butz 1979: 309-17; Mauer 1983: 68f).[6]

Early Plowing and Harrowing

Two operations were performed with the plow: early plowing, which broke up the soil after the harvest, and plowing during sowing. The first of these was done by a special kind of plow, attested in Sumerian as *tug₂-sig₁₈* and its variants in the Sargonic and Ur III periods (see Civil 1994: 168). This so-called 'deep plow' or 'breaking plow' made three passes over a field, likely at right angles to each other, and with various modifications to the plow at each stage. The amount of land plowed by this practice in a given day was 75 to 100 *sar* (2,925-3,600m^2 per day; see Civil 1994: 76-77).

Harrowing followed deep plowing. In Ur III times, one to five passes was the average range required: three was most common, with 4.5 to 6 *iku* (16,200-21,600m^2) (1 *iku* = 3600m^2) harrowed per day (Civil 1994: 77). As for the harrow itself, it was a beam of wood with teeth, according to textual sources; however, bundles of reeds may also have been used. As with deep plowing, harrowing was done while the soil was still damp and clods could still be broken up.

Breaking of Clods

The breaking of clods in furrows is attested in the cuneiform record. Rates of 360-720m^2 per day per person are attested (Civil 1994: 78).

Irrigation Network

Maintenance of the irrigation network is an essential part of the agricultural cycle. Among the numerous processes, the digging and/or clearing of smaller irrigation channels was routinely performed, sometimes after manuring. This took place before the beginning of the flood season.

Sowing

Two methods of sowing were practiced: broadcast sowing and sowing by means of the seeder plow. Broadcast sowing could be done before *or* after final plowing and harrowing; sowing beforehand helped bury the soil, protecting it from birds, ants, and other pests.

Broadcast sowing could follow one of several procedures. In one arrangement, the symmetrical *ard* would set up ridges in the field, then the seed would be broadcast and the plow would make another pass to split the ridges. This arrangement sets the seed at a maximum depth of ca. 10cm, with row spacing at about 40-45cm and row width at about 10-15cm; as noted by Hillman, '[i]n view of the sowing in widely spaced rows indicated in some Sumerian texts...such a system for producing rows without the help of seeder *ards* or any resort to dibbling is perhaps of interest to Sumerologists' (Maekawa 1984: 77-78 & 87; Postgate 1984a: 100; Hillman 1985: 5).

In some cases, sowing may follow an initial irrigation to allow germination of the seeds – a natural barrier against the grain being eaten by birds and other pests (Hillman 1985: 11).

Plowing rates using the symmetrical *ard* are available from ethnographic data. In recent studies of agriculture in Jordan, a team of oxen could till 0.3-0.4ha in an 8- to 10-hour day in dual traction; a team consisting of two donkeys could till 0.2-0.3ha. (Palmer & Russell 1993: 48; Widell 2003: 721).

It is generally assumed that most of the sowing in the Bronze Age south was done with a seeder plow, which is first attested in iconographic evidence from the Early Dynastic period (Hruška 1985: 51 & n.18; Potts 1997: 78). The seeder plow revolutionized agriculture and, by allowing more seed to be conserved, may be responsible for the enormous yields attested in Sumerian economic texts (see below). The plow team for the seeder plow required three men: one to steer the oxen, one to deposit the seed, and one to manage the plow; in the Ur III administrative texts, a team was expected to (ideally) plow around 45.5 hectares (7 *bur₃*) in a given season (van Driel 1999/2000: 86).

Furrow spacing with the seeder plow and sowing-rates are readily available. *The Farmer's Instructions* calls for eight furrows per *nindan* (ca. 6m), a well known standard in Old Babylonian times, with one grain of seed sown every two fingers. Furrows spaced at an average of 75cm may seem excessive and uneconomical, but such wide spacing may have been used as a measure to circumscribe lodging and to keep the barley and wheat from laying down (Civil 1999: 260f.). This produced an average seed-rate of 240 liters per *bur₃* (6.48ha). Administrative texts from the Ur period III show similar numbers: there, the number of furrows per *nindan* ranged from eight to 12, with 10 being the standard; at 10 furrows per *nindan*, this corresponds to a seed-rate of one *gur* per *bur₃*, or 300 liters for 6.48ha (or 13.3 liters for each *iku* [=3,600m^2]; see Maekawa 1984). Seed rates from the Early Dynastic to Old Babylonian periods range from 12 to 60 liters/*iku*; however, most of these hover around 12-15 liters/*iku*, probably reflecting sowing with the seeder plow-the higher seed-rates reflecting broadcast sowing (Jacobsen 1982: 64-65; Pettinato and Waetzoldt 1975: 281; Maekawa 1984: 79).

Another type of seeding may also have been employed using a device called *giš-gaba-tab* (Maekawa 1985: 103). With this type of 'manual seeding', seed-rates of 1.1, 1.2, 1.5, 1.6, and 1.8 *gur* per *bur₃* are attested, at 12 furrows per

[6] In southern Mesopotamia, archaeological evidence for the application of settlement refuse as manure has mainly been observed for the post-Seleucid period.

nindan. As for the total area of land seeded per day, rates of 1.35 to 2 *iku* per day are attested (Civil 1994: 75).

Removing Clods from Furrows
Instead of breaking clods, they were often removed; this took place after sowing without harrowing. Rates of 1,440 to 1,800m^2 per day per person are attested (Civil 1994: 86).

Irrigation
According to the *Farmer's Instructions*, irrigation should a) occur immediately after sowing, b) when the seeds have broken through the furrows, c) when the young plants form a surface 'like a reed mat', and d) when the grain turns from green to yellow (Civil 1994: 88-89). The last irrigation is of particular importance, increasing the harvest by 10% according to the same text.

Guarding the Crops
Guarding against pests was essential, especially for the free-threshing grains. In an experimental plot of cereals Hillman notes: '...we repeatedly had our bread wheat and even our hulled barley stripped by sparrows who, by contrast, quickly abandoned their attempts to extract grain from the ears of Emmer, Einkorn and other glume-wheats growing in plots nearby (1985: 5)'. In addition to birds, such as wild geese (?) (Akk. *qaqûm*, Sum. *u$_5$-sim-mušen*), sparrows and crows, the crop in the field had to be guarded against gazelles, onagers, wild donkeys and wandering cattle (Wasserman 1999; see also Osten-Sacken 1999). Guarding could have been done by children with rattles, or bird traps and the like; temporary stands could be built in the field for monitoring against pests. Several cuneiform texts record workers and officials assigned to these tasks (Civil 1994: 87-88; Wasserman 1999), which also appear in iconographic evidence (Crawford 1985: 74 fig. 3).

Harvesting
In some cases, young, ripening crops might be given over to forage or, later, plucked while they were still green.

The harvest of fully matured grain was by far the most demanding task involved with staple cultivation throughout Bronze Age Mesopotamia – if only because the window of opportunity was so small. While there are several techniques available for harvesting (including uprooting, plucking ears only, and cutting low on the grain stalk; see Hillman 1984), and these varied based on the grain cultivated and the intended use of various parts of the stalk, it appears the most of the harvesting in the south was done low on the grain stalk with the sickle. This is indicated above all by the logogram for 'to harvest' (Š***E.KIN***), which juxtaposed the sign for grain with the sign for work – originally a pictograph of a sickle; and by the fact that the straw thus produced was a valuable source of fodder and fuel (see Hillman 1984: 119). This would have been particularly true for barley, but not so much for wheat, since its straw is not nearly as nutritious as fodder. Landsberger (1949: 262) provided evidence for the plucking of ears only during the Old Babylonian period. Elsewhere, Hillman notes that uprooting is most commonly applied to barley, with or without the sickle, while cutting low on the straw is most common for the free-threshing wheats (1985: 6).

The overwhelming majority of the actual harvesting was done by men, while women gathered the straw into sheaves (Hillman 1984: 118). Harvesting rates for one person in the Ur III period ranged from 0.8 to 1 *iku* per day.

Stacking of Sheaves and Field Storage
The stacking of sheaves for temporary field storage was a routine part of the cultivation process, at least for hulled barley and the glume-wheats; field storage is minimized with naked-grained cereals. Generally speaking, the sheaves were arranged with the ears of grain pointed inward to minimize the damage from birds and weather. Transport of the sheaves to the threshing floor resulted in grain loss, especially for the free-threshing wheats. Hillman notes: 'For barley and free-threshing wheats grown in present-day Syria under traditional husbandry...[there have been] recorded losses of 10-15% of gross grain yield. Evidence of these heavy losses can be observed during summer in the Near East along any track connecting fields and threshing yards: the ground is strewn with fallen grain destined to end up in rodent burrows, ant nests and the gizzard [sic] of sparrows or pigeons' (1985: 7). Transport was often done at night, when the wind was at a minimum and while the grain was still wet.

Quantitative data on the stacking of sheaves are available:10 piles of sheaves with a diameter of 1-1.5m(?) per day per person (see Civil 1994: 91, & 106 n. 108).

Threshing
The threshing of grain began with the preparation of the threshing floor, which was usually near a smaller settlement in the vicinity of the fields. The effect of threshing depends on the grain in question: for glume-wheats it removes the spikelets from the ear, along with the intact straw; in the case of barley removes the hulled grains from the ears; or in the case of free-threshing wheats removes the naked grain from the ear (Hillman 1985: 7; Charles 1984: 19). Three kinds of threshing are attested in the south: by sledge, by trampling, and by flailing. Quantitative data for threshing (by flailing) are cited by Civil: rates of 300, 240, and 80 liters of grain threshed per day per person are attested (1994: 95).

Winnowing
Winnowing after initial threshing separated the spikelets from the straw in the case of the glume wheats, or the grain from the straw and chaff in the case of the free-threshing wheats and barley (Hillman 1985: 8). Winnowing requires an open area with the right level of wind and, ideally, is done downwind from a settlement to prevent the straw and chaff from spreading across the site and creating a fire hazard. For free-threshing cereals, only a single episode of winnowing is generally necessary. In any case, the straw and chaff may have been collected for additional uses such as temper in bricks or pottery or fodder.

Quantitative data for winnowing indicate that, for first-round winnowing, 120 liters of grain could be winnowed in a day, while 15 liters of grain per day is attested for second-round winnowing (Civil 1994: 96).

Sieving
Sieving took place in several steps, depending on the grain in question and the end result sought. Coarse sieving could take place on the threshing floor itself to remove heavy straw and weed-heads and to isolate the spikelets of glume wheats. The same is true of medium-coarse sieving. Meshes for sieves varied and could be made of leather strips, wool, or even reeds, theoretically. Sieves were designed to let the grain pass through, in the case of heavier, unwanted particles, or to preserve the grain in the sieve, to remove smaller impurities.

Final Cleaning, Transport, and Storage
Final cleaning of the grain was generally done by hand, with the grain separated from the straw and chaff and from weed heads; healthy grain separated from diseased grain (by dunking); and the straw and chaff, in some cases, further separated and sorted for various uses. Seed-grain was set aside, and the rest was washed and stored in grain silos or encased in mud. A similar process is employed today in southern Iraq for temporary storage. For spikelets, however, after a portion was set aside for seed (usually larger spikelets), the rest required additional processing, usually parching and pounding, to remove the grain before cleaning and storage. The risk of loss during transport was minimized at this stage, the grain being transported in baskets or other containers. Rodents were a constant threat during storage, and generally accepted as a more or less unavoidable pest that only could be countered by magical means (Wasserman 1999: 342).

Where the straw was further separated, light straw was generally used for temper or fast-burning fuel; medium straw for fuel (especially when mixed with dung), and as temper or fodder; and heavy straw for fuel or fodder. Chapter 8 deals with further details and evidence concerning storage and consumption.

Additional Processing
As noted, additional processing is required to remove the grain from the spikelet in the glume wheats, and to remove the hull in the case of barley. Free-threshing wheats may have their bran removed, but this is not necessary.

Hulled barley can be eaten either raw or roasted (Hillman 1985: 4, 20). In most societies, though, the hull is removed to produce 'pearl barley', which is excellent for roasting, brewing, and malting, as well as for bread and simple groats. Hillman points out that 'most societies prefer it de-husked, and most are prepared to invest some effort to this end' (1985: 4). As noted by Charles, '[c]onsidering the time-consuming nature of these processes and the fact that the most important part of the food source is being lost, leaving only the starchy endosperm, it is surprising how universal and frequent this practice is' (1984: 19).

As with removing the spikelet, de-hulling (or de-husking) is done by pounding, usually with mortar and pestle; however, it involves soaking instead of parching. De-husking involves additional winnowing and sieving as well. There are no ancient quantitative data concerning the removal of the hull from barley, or of the spikelet for the glume wheats.

A common traditional practice that appears to have occurred also in ancient times is the early harvesting of grain while it is still green. Not only does this have the advantage of sometimes avoiding tax, but, when cooked, the grain can produce a sweet, succulent dish called *frik*é (Hubbard & al-Azm 1990: 105).

The final stages of processing grain to convert it to food involve grinding and roasting, above all. These steps are self-explanatory; those processes attested in the cuneiform record were summarized by Postgate (1984b). These include roasting, germinating or malting, and grinding. Most of our knowledge concerning these processes deals with the grinding; not only are there terms for various types of grinding (e.g., 'to grind coarsely' [Akk. *samādum*] vs. 'to crush (by pounding)' [Akk. *našālum*]), but we have quantitative evidence concerning the rates of grinding – from 3-9 liters of flour per person per day during Ur III period (Grégoire 1999). Chapter 6 provides further discussion of food processing.

Legumes and Pulses

Legumes and their seeds, also called pulses, were an essential part of not only the agricultural cycle but also the diet. Legumes are soil-enriching plants, particularly with respect to fixing atmospheric nitrogen. In smaller volumes, this enrichment resulted from allowing the plant to mature and harvesting its seeds; in larger volumes, it resulted from simply cutting the plant before it matured and plowing it, in its entirety, into the soil. According to Charles (1985: 40), legumes 'have also been used successfully in soil reclamation projects on the salinized land of Southern Iraq...', and these qualities could well have been appreciated in Sumerian times; indeed, there are indications that legumes were interspersed with grain, perhaps for this very reason (Maekawa 1985: 109). As for their other roles, pulses provided a critical source of protein in a largely cereal-based diet; moreover, they have a thick outer seed-coat (or testa), which prevents germination and allows them to be stored for 'several years at least' (Charles 1985: 41). Legumes are also excellent for animal diets, either as forage or when collected as fodder.

Like the cereals, virtually all of the pulses were winter crops (Yamamoto 1979, 1980; Powell 1984: 56). Charles provides a list of several legumes now found in the alluvial plain (1985: 56-57, tables 1 and 2).

As with the cereals, the identifications of the pulses are relatively secure but not certain. One of the principal pulses, the 'large pulse' (Sum. *gu*$_2$*-gal*, Akk. *ḫallūrum*), is often identified as the chickpea (*Cicer arietinum*). However, according to Stol, botanists attending the meeting of the Sumerian Agriculture Group in 1984 have argued that the chickpea cannot have been successfully cultivated in the extremely hot climate of southern Iraq, and Stol therefore suggested the alternative interpretation of the *gu$_2$-gal* as the broad bean (*Vicia faba*), which fares well in the conditions found in southern Mesopotamia (Stol 1985b: 128f.). The chickpea may have been referred to as the Akkadian *appānu* instead, which is attested in texts from Mari and Shemshara in upper Mesopotamia (Stol 1985b: 128), as well as in the archaeobotanical record from various sites in the Levant and northern Syria/southern Anatolia (Miller 1992: 44f. and 1997: 131); there is a very limited distribution of the chickpea's wild progenitor to an area within the upper reaches of the Tigris and Euphrates rivers (Lev-Yadun *et al.* 2000). Alongside the 'large pulse' is the 'small pulse' (Sum. *g$_2$-tur*, Akk. *kakkû*),[7] which may be identified with the lentil (*Lens culinaris*); but it is also possible that it refers to the common pea (Stol 1985b: 130), which was found in the Early Dynastic Royal Cemetery at Ur (Renfrew 1985b: 68). The third most common pulse is likely the common vetch (*Vicia sativa*), known as Akk. *kiššanu* during the Old Babylonian period.

There is relatively little information on the cultivation of pulses versus the cultivation of grain. Plots were devoted to specific pulses, and the means of harvesting them depended largely on the splitting (dehiscence) of the pods and on plant height (Charles 1985: 42). As with the cereals, they can either be picked (and, if the pod is dehiscent, then it needs to be picked before the seeds are dispersed) or reaped by uprooting or cutting; the manner of harvesting will depend on the intended use of the various parts of the plant.

Quantitative data for pulse cultivation are also available. The tablet BM 19739 gives sowing rates for small pulses at 630 liters per *bur$_3$* (Maekawa 1985: 103). Yields of big pulses range from 425 to 681 liters/ha.

Oil Plants

Among their many uses (as fuel, lubricants, etc.), oil plants provided an important source of fat in the cereal-based diet found in Mesopotamia. They produce two kinds of oil: fixed oils, which are 'greasy, non-distillable substances, (and) non-volatile' and used for cooking, illumination, and soap making; and essential oils, which are 'non-greasy, volatile, and often strongly aromatic' and limited to medicine, cosmetics, or for flavor (Charles 1985: 50). Unlike the north, which showed extensive olive production (see above), oil plants in the south were pulses and, as such, winter crops. However, there are summer versions attested – even as forms of the same species – which are sown in March-April. The oil plants are known for low sowing-rates and yields.

[7] Also called *gu$_2$-nig$_2$-ar$_3$-ra*, 'pulse for grinding', in the Old Babylonian period.

Identification of the oil plants is similar to that of the other crops. Archaeobotanical remains, some dating as far back as Ubaid-period Ur, suggest that the primary oil plant was cultivated flax or linseed (*Linum usitatissimum*), a winter crop (Renfrew 1985a; Waetzoldt 1985: 78). This would seem to be supported by early iconographic evidence, above all from the Uruk vase: it depicts barley, a plant which appears to be flax, and another unidentified plant as the bases of Sumerian life (Crawford 1985). However, its height as shown on the vase, if it is accurate in relation to the other plants depicted, suggests that flax was grown for fiber, not oil. This is further supported by contemporary references to linen (Sum. *gada*; ibid. 74). Flax is also attested in Uruk III and Jemdet Nasr texts (Waetzoldt 1985: 77).

The most common oil from an oil plant attested in cuneiform records is Sum. *giš$_3$* (Akk. šamaššammu), which is identified with sesame (a summer crop), not flax (Sum. *gu*; Akk. *kitû*; see Kraus 1968; Stol 1985a). According to Waetzoldt, there is no mention of flax oil in cuneiform records, only of flax seeds (1985: 77).

Both sesame and flax have maturation periods of three to six months (Waetzoldt 1985: 81). Cuneiform texts from Lagash show that sesame was sown in May/June and likely harvested in August/September; Old Babylonian field rental records for sesame cultivation further support this (Stol 1985a: 119).

Quantitative data concerning the sowing rates of oil plants include an Old Babylonian letter, which indicates 7 liters per *iku* (Stol 1985: 120). The oil yield from the sesame seed appears to have been 20-22% in the late third millennium (Waetzoldt 1985: 81).

Processing of Oil Plants

Oil can be extracted from oil plants by rendering or pressing, the means depending on how the oil is stored in the plant. For all plants with oil stored in their seeds as opposed to the fleshy part of their fruit (as in, say, olives), oil is extracted by pressing. Pressing can be hot or cold. In cold pressing, the seeds are pounded or ground to get a type of meal, which is then pressed, leaving a cake – which itself can be pressed again or used as animal feed (Charles 1985).

Unlike the Sumerian word for pressing (the blanket term *sur*), Akkadian terms show various levels of detail. The verb *ḫalāṣum* suggests the application of light pressure through a sack; the verb *ṣaḫātum* implies a process more like wine pressing. These interpretations may be problematic: sesame oil is traditionally obtained by boiling the seeds and skimming the oil (Stol 1985a: 121); *ḫalāṣum* is also used for treatments of flax, hair, and wool, which are connected in obvious ways. The *Bulletin on Sumerian Agriculture* group seemed to agree that the verb involved pounding the sesame in a mortar and crushing warm seeds in a mill, with *ṣaḫātum* denoting the crushing of (warmed) seeds in a mill and extracting the sesame from the pulp.

Dates (Phoenix dactylifera)

The date palm of Iraq (*Palmeae Phoenix dactylifera*) forms an important part of the local economy, providing resources for food, lumber, basketry, and fuel. It grows in elongated orchards along the rivers and canals of southern Iraq (Chapter 4), and although it has the highest tolerance against soil salinity among the major cultivable crops, it thrives and matures its fruit in this region's intense climate only with an abundant supply of water. Its distribution extends as far north as Ana and Samarra; it also occurs as far north as Mosul, but usually does not fruit so far north. However, the most important region for its cultivation is the Shatt al-Arab. During the early twentieth century in this region, gardens lining both banks extended outward for about a mile, covering roughly 138,000 acres, on which grew fifteen to sixteen million date palms (Dowson 1921: 4-5). These trees appear at least as early as the third millennium BC in Mesopotamia, but in neighboring Kuwait date stones from excavations have been dated to the early fifth millennium BC (Charles 1987).

The Tree

The date palm, when cultivated, grows to a height of 20-25m in a single trunk with a crown of pinnate leafs 2-3m in length (Charles 1987). If left unattended, new offshoots will cluster at its base and eventually become full-grown palms. The date palm grows male and female flowers on different plants and pollination must occur for the plants to reproduce. Wind pollination may take place, but that process tends to produce small, stone-less fruits. As a result, hand pollination by cultivators has become part of the farming practice. The fruits produced are 1-2cm wide by 3-4.5cm long, and contain a seed pit of roughly 0.5-1cm by 1-2.5cm (Charles 1987). The dates ripen at an even pace through a cycle of stages which demonstrate various qualities that may be better suited for transport or immediate consumption. During the harvest season yields may vary, but generally follow a pattern in which a large crop one year is followed by a smaller one the next. Overall, on average about 20kg per tree (Popenoe 1973) or 5,000kg/ha (Charles 1987) may be expected each season.

Although seeds may be used to grow a palm tree 'from scratch', this method is considered undesirable because the sex and quality of the resulting tree remain unknown. It should also be noted that date palms propagated from seeds often exhibit marks of deterioration from their 'parent' tree (Pruessner 1920: 216; Tengberg 2009: 239). As a better alternative, an offshoot from the base of an existing tree may be removed when it is about four years old and planted directly into the ground. This was almost certainly also the preferred method of planting date palms from the very beginning of their cultivation in southern Mesopotamia. As observed already by Scheil in 1913, the practice of artificial fecundation of the female date tree can be attested in cuneiform texts from the late third millennium (see also Tengberg 2009: 240), and male trees were grown separate from the fruit-bearing female trees in the large palm orchards attested in this period of time. Several paragraphs in the *Codex Hammurabi* (§§60-63) concern the responsibilities and obligations of the gardeners planting new date orchards, and from these provisions it is entirely clear that young palm trees in the OB period were exclusively offshoots from parent trees (see Pruessner 1920: 213 & 216-18).

To reach a maximum yield from each tree, cuttings are planted at the corners of squares with 16-cubit sides (about 7.32m) or, in the Shatt al-Arab, at corners separated by seven yards, or 6.40m (Dowson 1921). It is more difficult to arrive at any clear conclusions regarding the density of trees in the ancient Mesopotamian palm groves, since palm orchards in the cuneiform record generally were defined only by their number of trees without any information regarding their measurements. However, the Old Babylonian document *VS* 13 70 and 70a (i.e., the envelope) from ancient Larsa is an important and interesting exception to this rule. In this text, a date orchard measuring 70 *sar* (approximately 2520m^2) containing 25 date palms is sold for a sum of 6.5 *gin*$_2$ ('shekels') of silver (around 54g). Using these numbers, we can conclude that one hectare of palm plantation would only include some 99 trees in the area around Larsa, and that the average spacing between the trees would be around 10 meters. Such wide spacing between the trees would result in higher yields than in orchards with trees planted 6.5-7.5m apart. One could argue that the reason that the size of the orchard is included in this sale document is because the density of palm trees in this particular plantation deviated from the norm, and that the text therefore cannot be used to reconstruct the standard tree density in Old Babylonian date orchards. Moreover, as any Assyriologist can attest, it is always a problematic business to create models or draw conclusions based on a single attestation (hence the well known adage *testis unus, testis nullus* 'one witness is no witness'). Nevertheless, the average silver value for a single tree in the OB sale document (about 48 še, or 2.17g) is certainly comparable (even somewhat low) to the average value of a palm tree of around 2.38g silver (prices ranging from 1.85g to 2.78g) in similar sale documents from the late third millennium (see Widell 2005b: 394), and it is at least possible that the relatively low tree density found in *VS* 13 70 and 70a reflected Old Babylonian cultivation strategies for palm orchards.

The life cycle of the date palm, as indicated by when it begins and ceases to bear fruit, may last anywhere from 30 to 100 years. The palm tree also acts as a mediator against regional climatic extremes, enabling the growth of other crops below. These often are grown in a three-tier system, with (for example) fruit trees below palms and, in turn, annual plants below fruit trees. Together this rich microclimate and soil environment helps replenish soil nutrients. The lower story plants include fruit trees (discussed below), vegetables (e.g., onions, spinach, cabbage, carrots, potatoes, and mint), curcurbits (e.g., melons, gourds, and pumpkins), pulses, cereals, fibers, dyes, and oil plants. Additionally, when the gardens are not actively cultivated, they may be used as grounds for grazing animals.

Date Cultivation Practices

During the winter months the soil is enriched with animal and human dung, plant material, and other organic material in order to maintain a high quality for cultivation. Additionally, a practice documented in the Shatt al-Arab called 'tillage' is undertaken every four years, in which three men dig the land around a tree to a depth of four feet, remove old roots, and add manure. This painstaking process takes about one to two months for one acre, and hence is only applied to the highest quality gardens. A palm grove may be left unattended, but this neglect will produce a crop of lower quality and quantity. Additionally, for maximum yield, the gardens must be supplied with plentiful water throughout the year – especially during the hotter months: either through tidal inundation from river overflow, gravitation flow, or a lift mechanism.

Pruning is also undertaken as a regular practice every year. This process normally includes the removal of dead or dying outer fronds at roughly a foot away from the trunk of the tree. Furthermore, when a palm has reached its fourteenth year, the expanded bases of the fronds are cut away close to the trunk in order to kill any sucker buds. This exercise may occur at any time of the year, but is often synchronized with the artificial fertilization of the trees in order to prevent the need to climb the same palms repeatedly. For this operation, a cultivator extracts a sprig of the ripe male pollen and inserts it into the middle of the female inflorescence using a brush or sponge. In order to maintain a high quality of fruit, superfluous flowers or branches may also be thinned out.

Harvesting usually begins when the majority of the dates have ripened. Large bunches are cut at a time, and all the dates of one type in a garden are removed before beginning to harvest those of a second type. During this process the dates are placed into palm-fiber baskets and piled in one section of the garden. The labor is split into three main roles: the *jani* cuts the date bunches, the *towash* picks up the bunches, and the *nagil* carries the dates away in baskets. Overall, the cultivators are paid a share of the total crop group, but the secondary products of the palm are divided between the garden-owner and the cultivators. According to the *Codex Hammurapi* (§60), the gardener of a new orchard was entitled to half the produce from the fifth year after a new orchard was planted (i.e., the first year a reasonable produce could be expected from palm trees planted from offshoots), the other half belonging to the owner of the orchard (who would be entitled to pick first from half of the orchard). Thus, during the first four years of planting a new palm grove (which certainly involved a very large amount of work) the only compensation for the gardener was the produce of any additional crops, such as fruit and vegetables (see below), which were planted under and around the young palm trees in the orchard (Pruessner 1920: 217). In addition to the laying out of the orchard, the gardener would be responsible for surrounding the grove with a mud-wall; providing, planting and continuously pruning the palm trees; removing flowers and new strands to provide more sunlight for the fruits; irrigating the grove; artificially pollinating the fruits; harvesting the dates; and generally protecting and guarding the orchard from any kind of harm (Driver & Miles 1952: 158).

The Uses and Products of the Date Palm

The flesh of dates with a 20% moisture content is composed of approximately 60-65% sugar (80-85% in dried fruits), 2.5% fiber, 2% protein and somewhat less than 2% fat, and will furnish around 3,150 calories per kg. In addition, dates are a good source of iron, potassium, calcium and niacin (Nixon 1951: 287f.). In addition to eating both fresh and dried dates, the people of ancient Mesopotamia also used dates to produce a sugary syrup which was used in cooking, baking and as an important ingredient in barley beer. The date stones could be used for charcoal making or ground and used as fodder, while the palm trunks (in all likelihood those taken from unwanted male trees) provided timber for boat building as well as various types of constructions, such as walls, bridges, embankments and, in particular, roof beams. The heart of the palm would be cut out and eaten or offered to the gods, and the fiber, offshoots and fruit stalks used to weave a rough rope. The fruit bundle, and possibly also the fiber, was burned for fuel, while the leaflets were shaped into storage baskets and matting, and the empty spathe of the palm and the frond bases were used as brooms (Potts 2002: 21). Finally, as already mentioned above, one economically important role of the date palm both in antiquity and in modern plantations is to provide shade and shelter for crops such as fruits and vegetables planted in the orchards beneath the trees.

Other Fruits

In addition to the date, a broad array of fruits was grown in Bronze Age southern Mesopotamia. General terms for fruit (Sum. *nig*$_2$*-sa-a* or *nig*$_2$*-sa-ha*, and *gurun*; Akk. *muhummu*, and *inbu*) as well as terms for specific fruits were discussed by Postgate (1987). Given the height of date palms, other fruit trees were routinely grown under them, providing a substantial additional income for the orchard (see Widell 2005b: 395f.). Today these primarily include the apple (*Pyrus malus*), almond (*Prunus amygdalus*), and apricot (*Prunus armeniaca*) in the alluvial plain (Charles 1987: 4); there is evidence for the fig and possibly also the mulberry and pomegranate being cultivated within a date plantation in antiquity (Postgate 1987: 122; Willcox 1987).

Since fruit trees have long branches covering a large area, they are usually irrigated in 'small basins around the base of the tree… or in furrows with the trees planted along the sides or the furrow bottom' (Charles 1987: 5). Another distinction made in the cultivation of fruit trees is whether they are being grown for their fruit or their timber. Fruit trees grown for timber are planted at higher density to encourage competition for light, which yields taller trees (Charles 1987: 5).

The various terms for fruit trees in cuneiform sources were discussed in detail by Postgate (1987, 116, Table 1). These include the grape (Sum. *geštin*, Akk. *karānu*), fig (Sum. *peš*$_3$, Akk. *tittu*), apple (Sum. *hašhur*, Akk. *hašhūru*), and, perhaps, the pomegranate (Sum. *nu-ur$_2$-ma*, Akk. *nurmû*) and the white species of the mulberry (*Morus alba*, Sum. *UR$_2$xA.NA*, attested at Ur and Umma [see Postgate 1987: 120; for the pomegranate at Old Babylonian Mari, see Sasson 2004: 189]). It should be noted that Gelb identified *hašhur* with the apricot since it appears on strings, like figs, in cuneiform sources (Gelb 1982); this and other identifications have now been abandoned in favor of the apple (Powell 1987). In the archaeological record, strings of crab apple rings (Pyrus malus) are attested in the Royal Tombs of Ur (Renfrew 1987: 157). As with the date, other fruits could be fresh (Sum. *duru$_4$*) or dried (*had$_2$*).

Cucurbitaceae

The members of the *Cucurbitaceae*, including the cucumber and various melons, are attested for the Bronze Age. Cultivating these species requires good land, generally orchard land; the addition of manure as fertilizer; and hoeing to keep the soil loose and to remove weeds – a delicate procedure, since *Cucurbitaceae* roots grow close to the surface of the soil. Today, they are grown in the winter, spring, or summer. For the winter cycle they are sown in January, usually in a garden, and later moved to a field in February or March, where they mature for another month. For the spring cycle, they are sown in mid-March; for the summer, in May-June – usually in fields or along river beds once the water level has decreased (Charles 1987: 9). Seeds are sown along both sides of a ridge, with 2-4m between ridges and plants 0.5-1.0m apart. They can also be planted in mounds within irrigation basins, in orchards (under date palms), or in open fields with fronds spread over them for shade. As with some other plants, harvest periods vary with the product (Charles 1987: 8); harvesting techniques are rudimentary, with either the vine being cut or the fruit being removed. Yields of between 4,000 and 32,000 kg/ha are attested, 8,000-10,000 kg/ha being the most common. The worldwide average in recent times is between 4,500 and 6,700 kg/ha (Charles 1987: 10).

There have been relatively few clear identifications of *Curcurbitaceae* in the cuneiform record. By far the most common was the cucumber (Sum. *ukuš$_2$* or *kuš*; Akkadian *qiššû*), but even that is rare. Nevertheless, the Sumerian term for cucumber doubles as the term for *Curcurbitaceae* in general, appearing as a determinative in Babylonian lexical texts, and a further distinction between winter and summer cucumbers may be reflected in the terminology as well (Stol 1987b: 82).

An 'Egyptian cucumber' (Akk. *tigilû* or *qiššû meṣru*) is widely attested in Babylonian medical handbooks (Stol 1987b: 84), and is used as a medicine and laxative in modern times (Charles 1987: 6). The plant designated by Akkadian *irrû* may be the wild melon (*Cucumis callosus*), not the colocynth, as often thought (Stol 1987b: 85). The identifications of various melons are otherwise difficult to confirm in cuneiform sources.

Alliaceae

The Alliaceae are among the most important staples cultivated in the south. Although these plants are perennials (or, in some cases biennials), we deal here only with those that were cultivated. The cultivated species of *Allium* plants today include onion (*A. cepa*), garlic (*A. sativum*), the leek (*A. porrum*), and the shallot (*A. ascalonicum*). These were cultivated as field crops or in gardens; preferably, it is the bulb that is planted.

By far the best-known evidence for onion cultivation in ancient Mesopotamia is the so-called Onion Archive of the Old Akkadian period, which deals with both the cultivation and distribution of onions (see Westenholz 1987). The problems of interpretation, here and elsewhere, involve the Sumerian term *sum* (Akk. šūmū), which denotes alliaceous plants in general. The difference is important, however: depending on the size desired, onions have a maturation period of three months, garlic of five months.

The Sumerian term *sum-sikil*, Akk. šamaškillu, is the most likely candidate for the onion, based on its Aramaic cognate and the fact that medical texts from Mesopotamia suggest chopping *sum-sikil* to cure dry eyes (Stol 1987a: 59). The cultivation of onions in cuneiform texts reflects elements of modern cultivation. In pre-Sargonic texts from Lagash and in Ur III texts, planting is indicated by the Sumerian verb *sur*, 'to press', suggesting that bulbs were pressed into the ground. Furthermore, harvesting is indicated either by the Sumerian term *bur*, suggesting the plants were plucked (Bottéro 1980-1983: 39), or by the Sumerian verb *ba-al*, 'to dig', clearly indicating that they were uprooted (Civil 1984: 293 n. 17; Waetzoldt 1987: 24; Charles 1987: 11). Harvesting times also reflect the various cultivation cycles, one of them being a bit earlier: in Ur III texts, onion harvests are attested in April, June, and August, the majority falling in the last cycle (Civil 1984: 293 n. 17).

Garlic (Sum. *sum*(*-sar*); Akk. šūmū), like the onion, is a winter crop because the roots need wet soil during the early stages of growth. Irrigation should be regular until shortly before the harvest to ensure good bulb formation (Charles 1987: 13). Garlic was harvested at the beginning of the Babylonian year, with deliveries attested around this time as well (i.e., in April; Stol 1987a: 58).

Sowing rates are well attested for all types of alliaceous plants (Waetzoldt 1987: 25, table 1); as noted, however, it is difficult to determine the identities of most of these, and the specific onion measurements used are not always entirely clear. Generally, the onion fields were planted with three types of bulbs/seed: onion (bulbs) (Sum. *sum^{sar}-gaz*) measured in '(onion) bundles' (Sum. *kilib*), 'single heads' (Sum. *sag-dili*) measured in *sila$_3$*, and (onion) seed (Sum. *numun*) also measured in *sila$_3$*. According to Waetzoldt's tabulations of several Ur III texts and his interpretation of the '(onion) bundle' (1987: 26 & 47, n. 35), one *sar* of land (approximately 36m^2) was planted with 1-2 liter of onion (bulbs), 2/3-1 liter 'single heads', and 1/2-1 liter (onion) seed. Converted into seed/bulbs per hectare, these three sowing-rates would represent roughly 278-556 liter onion bulbs/ha, 185-278 liter 'single heads'/ha and 139-278 liter seed/ha.

Leeks (Sum. *ga-raš*; Akk. *karašum* or *karšum*) are attested as well, while it is possible that the shallot (*A. ascolonicum*) is also attested in the Sumerian term *sum el-lum* (Stol 1987a: 60-61).

Meat

The nature of meat as a food source places it in a special category among the staples of Bronze Age Mesopotamia, in that it brought humans face to face with the taking of life and its associated trauma (Milano 1998: 111, with previous anthropological studies in n. 2). Accordingly, meat-eating is often marked by ritual activity, communal gatherings, etc. Sources for the identification of the animals consumed in Mesopotamia and in what cuts and amounts include administrative and ritual texts, osteological remains, and ethnographic evidence. Included here are those proxy indicators of meat consumption, such as itemized bride-prices and dowries that include animals, various types of gift involving animals, and the ubiquitous act of extispicy, the principal means of divination in Mesopotamia (Postgate 1992: 161).

While general studies of meat-eating in Mesopotamia exist (e.g., Limet 1988; Milano 1989; Kozuh 2010), nothing along the lines of Salima Ikram's thorough investigation of the subject for Egypt is available (1995). Our reconstruction is based on the various contexts in which meat is found in the cuneiform record. Thousands of texts deal with meat and, where they offer a context or any information about the consumer and the reason(s) for his or her allotment, they generally fall within the contexts of temple sacrifice, delivery to the royal table, delivery to or from various offices that deal with meat, and provisioning of troops or temple officials. Culinary texts also provide evidence for the consumption of meat (Bottéro 1987).

The number of animal species consumed in ancient Mesopotamia was staggering, and the evidence at hand no doubt represents but a fraction. These included above all the 'basic triad' of sheep, goat, and cattle, which dominated the south (Potts 1997: 86), to which we may also add the pig (see Dahl 2006). Given the environment of the south, fish and waterfowl (including their eggs) also formed a major component of the meat-based diet, if not *the* major meat component for the average person owing to the sheer number of and ready access to these animals. Other animals consumed include species of antelope, chickens, mice, rabbits, bears, crawfish, eels, turtles, crabs, various forms of insect, and, in at least one instance, the horse (Ebeling 1957-1971: 86; Postgate 1992: 158). Visual evidence of the species raised and, presumably, consumed is prevalent in the glyptic record. Postgate notes that the standard of Ur shows animals coming in, perhaps for a banquet, which offers visual evidence (1992: 146). More exotic species were found at the king's table at Mari and included hunted animals such as rabbits, wild sheep (moufflon)... 'even bears and park-raised deer' (Sasson 2004: 206-207 with n. 76; see also Wu 1996).

Meat preparation included roasting, boiling, drying, and salting; the consumption of raw meat was considered barbaric (Ebeling 1957-1971: 86). Some form of curing would have been inevitable for transporting meat over any real distance; generally speaking, this would not apply to internal organs, which do not cure well (Sasson 2004: 211).

As noted repeatedly in the literature, the extent to which meat formed a regular and substantial part of the Bronze Age diet, at least for the average person, remains unclear. Most sources tend to minimize its contribution owing to a) the high value of animal products such as milk and wool, and of animal labor; b) the fact that meat tends to appear in privileged contexts, such as at the 'meal' or 'table of the king' at Mari (e.g., Ebeling 1957-1971: 86; Potts 1997: 89; for the Mari evidence, see Milano 1989, and, more recently, Sasson 2004); and, as noted above, c) the ritual contexts occasioned by the killing of an animal, which often involved communal meals or special events. The argument based on the use of animal products is most compelling; indeed, Russell notes that dairy can provide nearly four times the nutritional value of meat from a given herd (1988: p. 74, Table 5). The one exception to this trend, at least in our research, is Lucio Milano, who suggests that meat may have played a much greater role (1998: 111).

The consumption of meat in Mesopotamian settlements, at least with respect to the 'basic triad' (or tetrad, if we include the pig), is in part a function of its distribution mechanisms, which in turn goes to the larger economic and religious framework in which a settlement operates, be it palace, temple, general household, or some combination of these. Where distribution is concerned, Melinda Zeder (1991) has provided the most extensive study of the theoretical framework. In her study, distribution of meat is either direct, in which the consumer receives meat directly from the herder (i.e., where the herder, provisioner, and distributor are identical), or indirect, in which the consumer receives meat through various, intermediary channels. With direct distribution, the primary factor guiding the exchange is herd security and growth. As such, those animals destined for consumption are selected based on age and sex in a way that minimizes their impact on the perpetuation of the herd. The animals consumed will match those raised by the herder in fairly strict proportions, and butchering will generally take place at the point of consumption. With indirect distribution, the primary factor is the efficiency of the system in meeting distribution requirements. Here, the primary animals consumed will be determined by a maximum return of meat, or by those species that offer the most nutrition per portion. 'Given the different, perhaps even conflicting, goals of the herder and the provisioner,' the proportion of animals in the herd may differ considerably from that of the animals in the distribution network (Zeder 1991: 38), which will be relatively uniform; butchering is specialized and takes place away from the point of consumption, the meat being cut into standardized pieces for distribution.

The mode of distribution, according to Zeder, will have a direct impact on the animals eaten and on the specific subcategories within those animals that slated for this purpose. With direct distribution, goats and sheep (in that order) would likely provide the bulk of the meat, specifically males between the ages of six months and two years of age. These would be followed by cattle, specifically males 'older than six months and below the age when maximum weight for fodder investment is reached' (Zeder 1991: 40). For pigs, the majority of male piglets and a smaller percentage of female piglets would be slated for consumption to maintain herd growth; for Zeder, pigs form a supplemental source of meat beside the basic triad. With indirect distribution, cattle at around four years old would be the principal animal used for food since they provide the most meat per animal, followed by male sheep and goat between two and three years old, which provide more calories per portion. Pigs would also be a strong candidate since they provide the most nutrition per edible portion than any of the other animals and reproduce very quickly. While six-month-old pigs provide optimal meat return, older pigs 'make more effective use of fodder… converting a larger proportion of nutrients into fat than into muscle' (Zeder 1991: 41).

The impact of the mode of distribution on meat consumption in ancient societies, as presented by Zeder, can be tabulated as follows (Table 5.3):

Table 5.3 Expected patterns of meat distribution (from Zeder 1991: 43).

Measure	Direct	Indirect
Species	Greater diversity; higher reproductive rates (goats, sheep, cattle)	Less diversity; greater meat yield (cattle, sheep, goats)
Age and Sex	Greater diversity; males between 6 months and 2 years	Less diversity; males between 2 and 3 years
Butchery and preparation	Even part distribution; greater variation	Selected parts; more standardization

The extent to which households and institutions followed one or the other mode of distribution is not always clear, and allotment must be made both for the supplemental procurement of meat through hunting and for other factors, such as taboos, that determined which animals were or were not eaten. Nevertheless, both modes were followed in antiquity, and Zeder's model provides a viable framework for a model settlement, some of her observations being corroborated by the evidence. It should be noted that the mode of distribution need not be tied directly to a given economic context or structure. For example, a palace or temple household, representing an institutional context, may have its own herds and herders, with meat procured by its other affiliates directly or indirectly. Moreover, temple, palace, and private household economies all interacted in myriad ways, both following and violating Zeder's proposals.

Milano's argument for a broader consumption of meat is tied to his understanding of the ways in which the two major institutional contexts in Mesopotamia relate to it:

> 'In spite of the common opinion that meat had a rather marginal role in the diet of ancient Near Eastern societies, one may wonder whether a regular system of distribution of meat existed in some periods, and to what degree it was related to the sphere of cultic practices. It seems to me that two different systems can be distinguished in the Syro-Mesopotamian world. One is strictly bound – at least in origin – to the temple economy and is used to channel meat from offerings to either court officials or temple personnel. In most of the cases, one deals with the 'leftovers' of the sacrifice, which are then distributed according to the rank or function of the people involved… [T]his system has a long tradition, that dates back to at least the Old Babylonian Period, and continues down to the Neo-Assyrian and Neo-Babylonian periods.
>
> The second system is based on the delivery of cuts of meat referring to metrological standards, and has no direct connection with the performance of sacrifices. In this case, the distribution of meat is the product of regular butchering and is intended not only for the table of high officials and for special occasions, but also for dependents of lower rank, performing their service at the palace... As against the ration system *stricto sensu*, this way of distributing meat is only occasionally documented, but in certain periods and areas it must have been integrated in the administrative procedures for compensation of work.'
>
> (Milano 1998: 120-121)

He goes on to claim that, by the first millennium, one sees a 'structure system' rooted in the temple and palace economies, with meat 'assigned by a royal decree as a permanent prebend to priests and to other personnel of the court as a reward for their service' (1998: 126-127, with bibliography). Milano's reconstruction would suggest that Zeder's direct and indirect distribution are found in Mesopotamia in temple and palace economies respectively, but this is no doubt an oversimplification of the situation in antiquity. Indeed, these institutions were so large that they had their own shepherds, butchers, animal fatteners, etc., such that both indirect and direct distribution functioned within each of these institutions.

Specialists devoted to cooking within institutional contexts included 'cooks' or commissary managers (Sum.

muḫaldim, Akk. *nuḫatimmu*), who seem to have been butchers, more precisely, at Old Babylonian Mari (Sasson 2004: 192; on *muḫaldim* in the Ur III period, see Allred 2006). Special fatteners (Sum. *kurušda*, Akk. *marû*) are also attested for different households (see, Widell 2009). Perhaps the best-known source of meat in Bronze Age Mesopotamia was ancient Puzriš-Dagan (modern Drehem). The site, established in the Ur III period as an animal collection and distribution center, provided and received animals to and from various cities of the empire. The E_2*-uz-ga* establishment may also be connected to the processing of meat (see, further, Wu 1996).

The cuts of meat that formed provisions vary by time period. The haunch appears in Early Dynastic imagery, both with other cuts of meat, on tables, and inscribed as an identifying mark on various objects (it also appears as the leg of a chair). More quantitatively, at Old Babylonian Mari, both sheep and cattle were divided into *malāku* and *mēšertum* portions: an ox was divided into seven *malāku*, each of which is broken down into 6 *mēšretu*; for sheep the *malāku* represents 1/10 of the animal without further division. Milano, citing Durand, notes that a butchering procedure still exists today whereby oxen are divided into seven parts and sheep into 10 (Milano 1998: 122). Prebend recipients in Neo-Babylonian Uruk received very specific cuts of meat from the animal in accordance with their rank (Capitanio 2004: 260-262; figure 2). Such data offer important evidence for what was considered the choicest cuts.

There is also evidence for meat going to non-elites. Recipients of meat from Drehem included the various individuals and households, even kennels and dogs used in military contexts (see Tsouparopoulou 2012: 3, 5f.). Female servants, among others, receive cuts of meat expressly designated for consumption (Sum. gu_7*-a*, '(to be) eaten') in Ur III administrative records; these references need to be examined more systematically. The texts from Mari show that servants would often get leftovers from the royal meal (Milano 1998: 115 with n. 18). Letters from Mari show that meat was dispensed to soldiers when they were in garrison (ARM 26, 331; cited Sasson 2004: 184).

Primary Sources of Meat

Sheep and goats provided the bulk of the meat in Babylonian texts. Sheep meat is fattier and provides more calories per edible portion of than both cattle and goats – namely 2,530cal/kg (Zeder 1991: 38). Goats have a nutritional density of 1,570cal/kg. At Mari, goats were killed very sparingly – 'almost exclusively… [at] covenant-makings with nomadic groups' (Sasson 2004: 209).

Cattle provide the most meat per animal in the triad, and are second to sheep in their nutritional 'density' at 2,360kcal/kg, but beef was certainly less common as food in ancient Mesopotamia.

Swine-herding also remains relatively poorly and unevenly attested in ancient documentation (see, e.g., Englund 1995), although if practical reasons were the principal guide to meat consumption, pigs would likely be the most common. Pork provides a higher nutritional density than any animal in the triad, at 3,710cal/kg; they provide 50% more meat than sheep or goat; 89% of its weight is edible; they have large litters and grow quickly; and they are easy to tend, even in the harsh climate of southern Mesopotamia (Zeder 1991: 38; Ikram 1995: 32). According to Jacob Dahl (2006: 32), pigs and humans can flourish together in Mesopotamia in an ecological microsystem, with humans providing shade and water for the pigs, and pigs processing the waste of the humans, transforming it into proteins; Dahl has successfully argued for the importance of swine-herding in southern Mesopotamia throughout the third millennium. Indeed, herds consisting of several hundred pigs are attested in Old Sumerian texts from the middle of that millennium (see Dahl 2006: 33-35). In Mesopotamian texts, pigs are primarily a source of fat or lard (Sum. i_3-$šah_2$), not of meat; perhaps in the Akkadian period, lard was replaced by sesame oil as the principal source of fat (Postgate 1992: 166). Nevertheless, it is clear from the Ur III period textual evidence that lard remained important in the economy into the late third millennium, and that pigs were clearly herded, and eaten, from the late Uruk through the Ur III period (Dahl 2006: 36f.). Archaeological evidence suggests that pigs were slaughtered as piglets (Potts 1997: 86); this corroborates nicely with the evidence from Anatolia, where Hittite texts record pig sacrifices in which some of them were explicitly eaten (de Martino 2004). The wild boar was clearly eaten as well, as numerous depictions of boar hunting are preserved (Potts 1997: 86-88).

Fish and Fowl

As noted, along with waterfowl, fish no doubt formed the principal source of meat for the average person in Bronze Age Babylonia. Fish provide protein, vitamin A, magnesium and phosphorus and 'can provide humans with 70% of the necessary protein required for humans' (Ikram 1995: 34). The number of species is not known; in the Nile valley, there were 'twelve families of fish, yielding approximately fifty-six species that were easily available' (Ikram 1995: 36).

Two example show the ubiquity of fish in the Babylonian diet. Fish were among the items given to messengers, along with beer, bread, and oil, as basic provisions (Postgate 1992: 147). In the Ur III period, there was a whole industry devoted to fishing (Englund 1990). Whether fish were farmed in addition to being wild-caught is not known.

Waterfowl formed one of the major meat-based staples in southern Mesopotamia, owing to the riverine environment. The species eaten was no doubt numerous and is not known; a list of 'Ur III delicacies' includes 'ducks, swallows, herons and crows' (Postgate 1992: 158), and ostriches are known to have formed part of the royal meal at Old Babylonian Mari (Sasson 2004: 206). In some cases, birds were very likely force-fed to fatten them for particularly special meals, as found in Egyptian iconography (Ikram 1995: 24, see 11, fig. 3). Fowl such as pigeons and what are probably ducklings and sparrows were found in culinary texts (Bottero 1987: 11-20, cited Potts 1997: 89).

In addition to their meat, birds also provided eggs. Eggs from fowl were among the most nutritious staples in the Mesopotamian diet, providing most of the necessary nutrients except for vitamin C (Ikram 1995: 25). The eating of ostrich eggs is attested at Old Babylonian Mari; they were either boiled or fried in oil (Sasson 2004: 187 n. 20; 188 n. 22).

CONCLUSION

The detailed account above gives just an idea of the sheer quantity of material available on food and food production in ancient Mesopotamia, and which was potentially available as input for the models (Table 5.1). Although it was possible to use only a small portion of these data, the above indicates how such materials could in future be employed as input for detailed and sensitive models of the Southern Mesopotamian agricultural economy.

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Edited by

T.J. Wilkinson
McGuire Gibson
Magnus Widell

BAR International Series 2552
2013

Published by

Archaeopress
Publishers of British Archaeological Reports
Gordon House
276 Banbury Road
Oxford OX2 7ED
England
bar@archaeopress.com
www.archaeopress.com

BAR S2552

Models of Mesopotamian Landscapes: How small-scale processes contributed to the growth of early civilizations

ISBN 978 1 4073 1173 9

Printed in England by Information Press, Oxford

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