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Nutrition and the Early-Medieval Diet

By Kathy L. Pearson

The food supply of the temperate lands of early-medieval western Europe, and the ways in which its peoples dealt with the central problem of feeding themselves, has been subjected to a variety of interpretations in recent years.¹ Vern Bullough and Cameron Campbell's study of the medieval diet and female longevity concluded that early-medieval women suffered from iron deficiencies triggered jointly by poor nutrition and frequent childbearing and that these deficiencies contributed substantially to their average early age of death.² Ann Hagen's overview of Anglo-Saxon patterns of food production and consumption suggested that most of the early English population routinely lived at marginally adequate or outright substandard levels of nutrition.³ Similar conclusions were reached by Renée Doehaerd in her study of the early-medieval economy.⁴ Michel Rouche, on the other hand, asserted that the typical Carolingian—including the peasants—had access to a monotonous, but abundant, supply of foodstuffs and may have consumed an average of 6,000–9,000 calories per day.⁵ Richard Hodges likewise decided that Anglo-Saxon peasants were reasonably well fed, based on the heavy food rents

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¹ "Early-medieval western Europe" is here used to refer to those lands that were formerly part of the Roman Empire of the west and their adjacent frontier zones during the time frame c. A.D. 450–900. These lands share three characteristics that make them useful for an analysis of dietary habits: they fall within the temperate zone, which gives them a very rough similarity of climate; they were at least marginally Christian from a relatively early date and hence theoretically subject to religious guidelines on food consumption; and they all offer archaeological or other evidence for foodstuffs and diet. I have reluctantly excluded Italy and Spain on several grounds. Both exhibit exceptional climatic and ecological diversity within their boundaries: the disparities between the agriculture of such regions as Sicily and the southern Tyrol or between Andalusia and the Pyrenees make any discussion one more of contrasts than of similarities. Both lands also retained a substantial Roman identity far longer than did lands north of the Alps, and their population densities were greater, factors that affected both food preferences and cultivation strategies. And finally, both Spain and Sicily were conquered by the Muslims during the eighth and ninth centuries. The culinary consequences of those conquests, essential to any discussion of Spanish or southern Italian foodstuffs, are too extensive for consideration within the present inquiry.

² Vern Bullough and Cameron Campbell, "Female Longevity and Diet in the Middle Ages," *Speculum* 55 (1980), 317–25.

³ Ann Hagen, *A Handbook of Anglo-Saxon Food Processing and Consumption* (Chippenham, Eng., 1992).

⁴ Renée Doehaerd, *The Early Middle Ages in the West: Economy and Society*, trans. W. G. Deakin (Amsterdam, 1978).

⁵ Michel Rouche, "The Early Middle Ages in the West," in *A History of Private Life, 1: From Pagan Rome to Byzantium*, ed. Paul Veyne (Cambridge, Mass., 1987), pp. 444–46, briefly reiterates his earlier discussion, "La faim à l'époque carolingienne: Essai sur quelques types de rations alimentaires," *Revue historique* (1973), 295–320.

per hide demanded (and presumably collected) during the reign of the West Saxon king Ina.⁶

Such disparate interpretations are created by the serious difficulties of reconstructing the early-medieval diet. Different climates, soils, and terrains forced local variation in the food supply. Social class and ethnic identity likewise shaped food consumption patterns. The Romanized aristocrats of southern Gaul ate differently from the Rhineland Franks living along the frontier. Regionalism resulting from post-Roman changes in long-distance trade also altered or created new food patterns. Population density determined both the nature of agriculture and the community's access to wild foodstuffs. The source materials themselves present a number of difficulties. Estate surveys and capitularies reveal the demands made upon their peasants by lords of large clerical and lay properties, but they tell us almost nothing of private peasant resourcefulness in producing foods from their exploitation of kitchen gardens and orchards or from the forests, meadows, and streams adjoining the cultivated lands. Such records likewise tell us nothing about populations living in more modest communities or in relatively isolated family groups. Nor do the surveys and capitularies address distinctions between sedentary, grain-raising communities and those pastoral populations whose primary dietary components would have been the meat and milk-based products of their livestock.

It is nevertheless possible to examine the general nature of the early-medieval diet and its health consequences. Estate inventories, capitularies, law codes, chronicles, histories, and monastic rules all offer some clues to foodstuffs and consumption patterns. Archaeology supplies us with plant, animal, and human remains. Known yields from the later Middle Ages through the early nineteenth century, used with caution, can suggest some upper limits for productivity. Twentieth-century scholarship has established some broad outlines of early-medieval agricultural practice. The use of all these sources collectively allows the reconstruction of a hypothetical diet whose nutritional value can then be assessed against modern standards. Specifically, this paper will address three problems: which foods, and consequently nutrients, were theoretically available to people; the accessibility of adequate amounts of those foods; and the implications of this diet for the health of early-medieval populations living within the confines of temperate western Europe.

The dietary significance of grains varied somewhat depending on the type of agriculture being practiced by local populations. Many early-medieval settlers of the fourth through eighth centuries may have practiced what Richard Hoffmann has described as "sedentary pastoralism," in which stock raising rather than arable

⁶ Richard Hodges, *Dark Age Economics: The Origins of Towns and Trade, AD 600–1000* (New York, 1982), pp. 130–41. Hodges does note (p. 139) that such high levies may reflect the need to create food stores that could be drawn on during times of shortages, and that these periods of shortages may well have been connected to a general deterioration in the climate of Europe between c. 400–500 and 800–900. Ina's legislation may be found in F. L. Attenborough, *The Laws of the Earliest English Kings* (New York, 1963), pp. 58–59.

agriculture played a dominant role.⁷ For these folk, grains were less important than the products of their animals. A shift toward more intense patterns of arable cultivation, and hence a greater dependency upon grains, commenced in the lands along the Rhine and in Francia north of the Loire during the seventh century and then spread outward from those regions. Among the contributing factors were an increasing population, settlement nucleation, and landowners intent on higher production levels and better control of their workers.⁸ Among the sedentary and heavily exploited populations associated with large clerical and lay estates grains became the primary foodstuff.⁹ Salic law punished trespass within the grain fields by marauding animals and predatory humans alike, and it established severe penalties for damage to the fields.¹⁰ The harvesting of grain or contributions of grain featured prominently among the workload or dues of many early peasants.¹¹ The versatile grains generated three basic foodstuffs: bread, which occupied a primary place in the diets of both rich and poor; beer; and gruels of various sorts.¹² The stalks and leaves could be fed to livestock or used as winter bedding. Dried grain could be stored for lengthy periods.

Early-medieval communities grew a variety of grains depending upon local conditions. Carbonized remains from seventh-century Engelschalking (now in Munich) indicate that six-rowed barley (*Hordeum vulgare*) predominated owing to its tolerance for cool and damp weather. Additional cultivars included emmer wheat (*Triticum dicoccum*), bread wheat (*Triticum aestivum*), einkorn wheat (*Triticum monococcum*), and spelt (*Triticum spelta*). Oats (*Avena sativa*) and rye (*Secale cereale*) were secondary crops.¹³ The twenty or so households within the Carolingian village of Kootwijk (near the lower Rhine due north of Arnhem) grew

⁷ Richard C. Hoffmann, "Medieval Origins of the Common Fields," in *European Peasants and Their Markets*, ed. William N. Parker and Eric L. Jones (Princeton, N.J., 1975), p. 38; his conclusions are based on the evidence of the various barbarian law codes.

⁸ Hoffmann, "Medieval Origins," pp. 42–43.

⁹ Among others, see Pierre Riché, *Daily Life in the World of Charlemagne*, trans. Jo Ann McNamara (Philadelphia, 1978), p. 172; Georges Duby, *Rural Economy and Country Life in the Medieval West*, trans. Cynthia Postan (Columbia, S.C., 1968), p. 9; and B. H. Slicher van Bath, *The Agrarian History of Western Europe, A.D. 500–1850*, trans. Olive Ordish (New York, 1963), pp. 40–74. For more recent interpretations, see Hoffmann, "Medieval Origins," pp. 29, 38–45; and Andrew Watson, "Towards Denser and More Continuous Settlement: New Crops and Farming Techniques in the Early Middle Ages," in *Pathways to Medieval Peasants*, ed. J. A. Raftis (Toronto, 1981), pp. 65–82.

¹⁰ *Pactus legis Salicae*, MGH LL 4/1:48–49, 74–75, 87, 99, 102–5, titles 9.5–9; 16.6–7; 22; and 27.6, 13–14, 17–21. A useful translation is Katherine Fischer Drew, *The Laws of the Salian Franks* (Philadelphia, 1991). Also see Drew, *The Burgundian Code* (Philadelphia, 1972), pp. 43–44, titles 33.4 and 37.1.

¹¹ For examples, see *Polyptyque de l'Abbaye de Saint-Remi de Reims*, ed. B. Guérard (Paris, 1853), pp. 1, no. 2; 7, no. 2; 21, no. 2; 78, no. 76; and *Polyptyque de l'Abbaye de Saint-Germain-des-Prés*, ed. Auguste Longnon (Paris, 1886–95), where each of the twenty-four enumerated villages has a host of peasants obligated to cultivate and supply grains. Also see *Lex Baiuvariorum*, MGH LL 5/2:286–90, title 11.13.

¹² On one use of gruel, see *Medieval Handbooks of Penance*, ed. John T. McNeill and Helena M. Gamer (New York, 1938), "Customs of Tallaght," p. 423, no. 52.

¹³ Hansjörg Küster, "Umwelt und Pflanzenanbau," in *Die Bajuwaren von Severin bis Tassilo, 488–788*, ed. Hermann Dannheimer and Heinz Dopsch (Munich and Salzburg, 1988), pp. 185–86. Grain finds are generally made only at sites where fire has preserved seeds through carbonization.

oats, barley, and rye, with rye being the dominant crop. Flax (*Linum usitatissimum*) was apparently cultivated both for its fibers and for its edible seeds.¹⁴ The Anglo-Saxon inhabitants of Wraysbury in Berkshire cultivated bread wheat, six-rowed barley, common barley (*Hordeum*), and oats. Emmer, spelt, and rye may have been either cultivars or weeds growing among the preferred grains. Wraysbury also offers evidence of companion planting of wheat and barley, which were always found associated in the excavated portions of the village. Wheat, the preferred grain, was somewhat more susceptible to climate variations, whereas the sturdier barley might thrive even if the wheat crop failed.¹⁵ Eighth- and ninth-century farmers at Dorestad planted rye, wheat, barley, and oats; the last-named two were companion planted at a ratio of 5:1.¹⁶ Frankish estate records illustrate that they, too, planted a variety of grains. The storehouses of Annapes contained no rye, but spelt, barley, wheat, and oats were all present in varying amounts.¹⁷ Millet (*Panicum miliaceum*) and panic wheat (*Panicum sp.*) are also mentioned in the capitulary *De villis*; archaeology thus far does not suggest that they were major food grains throughout the temperate zone.¹⁸

The cultivation of diverse grains by various communities was only logical. Wheats tended to yield a higher ratio of harvested grains for each seed sown, and their gluten properties made them the best grains for baking bread. They are, however, more demanding in their cultivation requirements than barley, rye, and oats.¹⁹ No community could afford to plant only wheat and risk the loss of the entire grain crop, and, in some communities, wheat seems to have been nearly impossible to cultivate.²⁰ A multitude of grains also allowed for more efficient use of the fields. Rye and wheat could be sown as winter crops, whereas barley and oats were more likely to be sown in summer or spring.²¹ Bread could be made

¹⁴ J. P. Pals, "Reconstruction of Landscape and Plant Husbandry," in *Farm Life in a Carolingian Village*, ed. W. Groenman-van Waateringe and L. H. van Wijngaarden-Bakker (Maastricht, 1987), pp. 60–61.

¹⁵ G. G. Astill and S. J. Lobb, "Excavation of Prehistoric, Roman and Saxon Deposits at Wraysbury, Berkshire," *Archaeological Journal* 146 (1989), 124–28.

¹⁶ W. Van Zeist, "Agriculture in Early-Medieval Dorestad, a Preliminary Report," *Berichten van der Rijksdienst voor het Oudheidkundig Bodemonderzoek* 19 (1969), 209–12; cited by Jean Chapelot and Robert Fossier, *The Village and House in the Middle Ages*, trans. Henry Cleere (Berkeley, Calif., 1985), p. 86.

¹⁷ *Brevium exempla ad describendas res ecclesiasticas et fiscales*, MGH Capit 1:254, chap. 25: "De conlaboratu: spelta vetus de anno praeterito corbes LXXXX, quae possunt fieri de farina pensas CCCCL, ordeum modios C. Presenti anno fuerunt speltae corbes CX: seminavit ex ipsis corbes LX, reliqua repperimus; frumenti modii C: seminavit LX, reliqua repperimus; sigilis modii LXXXXVIII, seminavit totidem; ordeo modii MDCCC: seminavit MC, reliqua repperimus. Avena modios CCCCXXX. . . ."

¹⁸ *Capitulare de villis*, MGH Capit 1:87, chap. 44: "De quadragesimale duae partes ad servitium nostrum veniant per singulos annos, . . . milio, panico. . . ."

¹⁹ Watson, "Towards Denser and More Continuous Settlement," p. 69; Pals, "Reconstruction of Landscape," pp. 59–60; and Slicher van Bath, *Agrarian History*, pp. 170–76.

²⁰ Pals, "Reconstruction of Landscape," pp. 59–61.

²¹ Pals, "Reconstruction of Landscape," pp. 74–75; Slicher van Bath, *Agrarian History*, pp. 58–62; Watson, "Towards Denser and More Continuous Settlement," pp. 68–73. The vexed question of crop rotation has been explored at great length; see the bibliographies of the above as well as those of Duby, *Rural Economy*; and Doehaerd, *The Early Middle Ages in the West*.

successfully from barley, oats, and rye, although their low gluten content limited the amount of rise produced by yeasts. Any grain could be converted into gruels or porridges, and both barley and wheat possessed the additional advantage of being easily converted into beer.²² All grains contributed vitamins K,²³ B1,²⁴ B2,²⁵ niacin,²⁶ B6,²⁷ folic acid,²⁸ potassium,²⁹ phosphorus,³⁰ and magnesium³¹ to the diet and were a good source of fiber, depending on milling techniques.³²

Legumes likewise formed a significant component of the diet of many communities. The seeds of broad beans, or favas (*Vicia faba*), appear among the grains at Kootwijk.³³ Peas (*Pisum sativum*), favas, and vetches (*Lathyrus sp.*) all grew in Saxon Wraysbury's fields, where their ability to enrich the soil rather than deplete it may have permitted the continued Saxon use of fields dating to the Roman era.³⁴ The tenants of Staffelsee and Annapes supplied their lords with lentils (*Lens cu-*

²² Elizabeth David, *English Bread and Yeast Cookery* (New York, 1979), pp. 45–49.

²³ Robert E. Olson, "Vitamin K," in *Modern Nutrition in Health and Disease*, 8th ed., ed. Maurice E. Shils, James A. Olson, and Moshe Shike (Philadelphia, 1994), pp. 342–58. (This standard reference text is hereafter cited as *Modern Nutrition*.) Vitamin K prevents hemorrhaging and promotes clotting of the blood. Deficiencies are especially hazardous for infants. Nutrient values of specific foodstuffs are from Jean A. T. Pennington and Helen Nichols Church, *Food Values of Portions Commonly Used*, 13th ed. (New York, 1980; hereafter cited as *Food Values*), and Ibrahim Elmadfa, Waltraute Aign, and Doris Fritzsche, *GU Compass Nährwerte*, 1992–93 ed. (Munich, 1991), p. 44 (hereafter cited as *Nährwerte*).

²⁴ Vichai Tanphaichitr, "Thiamin," in *Modern Nutrition*, pp. 362–65; *Nährwerte*, p. 45; *Food Values*, pp. 70–73. B1 deficiencies trigger beriberi, a disease found in populations whose diets are too dependent upon unenriched grains.

²⁵ Donald B. McCormick, "Riboflavin," in *Modern Nutrition*, pp. 366–75; *Nährwerte*, p. 48; *Food Values*, pp. 70–73. Deficiencies trigger anemia and dermatological problems.

²⁶ Marian E. Swendseid and Robert A. Jacob, "Niacin," in *Modern Nutrition*, pp. 376–82; Pierre M. Dreyfus and Masud Seyal, "Diet and Nutrition in Neurological Disorders," in *Modern Nutrition*, p. 1353; *Nährwerte*, p. 49; *Food Values*, pp. 70–73. Limited deficiency produces persistent fatigue and diarrhea, while serious deficiency causes pellagra.

²⁷ James E. Leklem, "Vitamin B-6," in *Modern Nutrition*, pp. 384–86. Deficiencies are rare, generally found only in famine conditions.

²⁸ Victor Herbert and Kshitish C. Das, "Folic Acid and B-12," in *Modern Nutrition*, pp. 402–3, 406–7, 410–18, 421–25; *Nährwerte*, p. 52. Folic acid prevents anemias and wasting syndromes. Deficiencies can trigger fatalities in pregnant women whose stores of folic acid have become depleted by several pregnancies and whose diets are nutritionally substandard. M. M. Werler, S. Shapiro, and A. A. Michael, "Periconceptional Folic Acid Exposure and Risk of Occurrent Neural Tube Defects," *Journal of the American Medical Association* 269 (1993), 1257–61, clarifies the link between spina bifida and folic acid deficiency.

²⁹ Man S. Oh, "Water, Electrolyte, and Acid-Base Balance," in *Modern Nutrition*, pp. 127–33; *Nährwerte*, p. 60; *Food Values*, pp. 70–73. Potassium's most important function is the regulation of body fluid levels.

³⁰ Lindsay A. Allen and Richard J. Wood, "Calcium and Phosphorus," in *Modern Nutrition*, pp. 155–63; *Nährwerte*, p. 63; *Food Values*, pp. 70–73. Phosphorus is required for metabolizing foodstuffs and interacts with both calcium and the B-complex vitamins.

³¹ Maurice E. Shils, "Magnesium," in *Modern Nutrition*, pp. 164–65, 171–73. Magnesium is required for the proper utilization of calcium, potassium, sodium, proteins, and carbohydrates. Deficiencies cause wasting, gastrointestinal disorders, and endocrine malfunction.

³² David, *English Bread*, pp. 16–35, 40–44, 47–48. David's book is both a treatise on all chemical and mechanical aspects of bread making and a cookbook.

³³ Pals, "Reconstruction of Landscape," p. 69.

³⁴ Astill and Lobb, "Excavation," pp. 125–27.

linaris), favas, and peas for storage in a central location; it is unclear whether these were cultivated in fields alongside grains or came from the kitchen gardens of peasants.³⁵ Salic law protected lentils, beans, and peas by punishing theft or intent to steal legumes from kitchen gardens and fields with fines ranging from three to fifteen *solidi*.³⁶ Beans of various sorts, chickpeas (*Cicer arietinum*), Moorish peas (*Vicia Narbonensis* or *Pisus arvensis*), and peas were ordered planted in Frankish royal gardens alongside herbs, vegetables, and fruit trees.³⁷ Legumes were even better suited than grains to long storage. All legumes supplied protein, complex carbohydrates,³⁸ dietary fiber,³⁹ and the micronutrients folic acid, B2, niacin, B6, potassium, magnesium, and iron.⁴⁰

Highly prized was meat of all sorts. In communities devoted to pastoralism, animals supplanted grains as the central component of the local diet.⁴¹ Archaeological evidence suggests that most communities greatly preferred domestic animals to game and that the majority of communities favored four domestic animals as their primary food beasts: cattle (*Bos taurus*), swine (*Sus domesticus*), sheep (*Ovis aries*), and goats (*Capra hircus*).⁴² Local preferences varied according to

³⁵ *Brevium exempla*, p. 252, chap. 8: “de lenticulis sextarium I”; and p. 254, chap. 25: “faba modium I, pisos modios XII.”

³⁶ *Pactus legis Salicae*, p. 100, title 27.7: “Si quis in orto alieno furauerit uel in furtum ingressus fuerit aut in napinam uel in fabarium, in pisariam, in lenticulariam et ei fuerit adprobatum, mallobergo leopardi sunt, excepto capitale et dilatura DC denarios qui faciunt solidos XV culpabilis iudicetur”; and p. 101, title 27.12: “Si quis in nabina, in fauaria, in pisaria, in lenticularia uel in his similibus in furtem ingressus fuerit cui fuerit adprobatum, mallobergo leopardi sunt, CXX denarios qui faciunt solidos III culpabilis iudicetur.” Fines approximated those levied for lesser mutilations and maimings.

³⁷ *De villis*, p. 90, chap. 70: “Volumus quod in horto omnes herbas habeant: id est . . . fasiolum . . . cicerum italicum . . . fabas maiores . . . pisos Mauriscos. . . .”

³⁸ *Food Values*, pp. 136–48; *Nährwerte*, pp. 20–21; Ian McDonald, “Carbohydrates,” in *Modern Nutrition*, pp. 36–46, provides an overview of the role played by carbohydrates in the body.

³⁹ Barbara O. Schneeman and Janet Tietyan, “Dietary Fiber,” in *Modern Nutrition*, pp. 89–100, analyzes the significance of fiber. Fiber contributes bulk to the colon and aids in maintaining water balance. Excessive amounts may cause the loss of micronutrients through fiber’s ability to absorb other chemical compounds as it passes through the digestive tract.

⁴⁰ Virgil F. Fairbanks, “Iron in Medicine and Nutrition,” in *Modern Nutrition*, pp. 192–205. Iron regulates the transport of oxygen to the tissues and controls the aerobic metabolism. Deficiencies trigger anemia.

⁴¹ See Watson, “Towards Denser and More Continuous Settlement,” pp. 65 and 69; and Hoffmann, “Medieval Origins,” pp. 33–45.

⁴² G. F. IJzereef, “The Animal Remains,” in *Farm Life in a Carolingian Village*, pp. 39–51; Astill and Lobb, “Excavation,” pp. 68–134; Finbar McCormick, “Dairying and Beef Production in Early Christian Ireland: The Faunal Evidence,” in *Landscape Archaeology in Ireland*, ed. Terence Reeves-Smyth and Fred Hamond, BAR British Series 116 (Oxford, 1983), pp. 253–67; J. M. Maltby, “Animal Bones and the Romano-British Economy,” in *Animals and Archaeology*, 4: *Husbandry in Europe*, ed. Caroline Grigson and Juliet Clutton-Brock, BAR International Series 227 (Oxford, 1984), pp. 125–38; Manfred Teichert, “Size Variation in Cattle from Germania Romana and Germania Libera,” in *Animals and Archaeology*, 4: 93–103; Teichert, “Die Tierreste aus der germanischen Siedlung bei Mühlberg, Kr. Gotha,” *Zeitschrift für Archäologie* 24 (1990), 45–66, who offers comparative evidence from a north-central German settlement; L. H. van Wijngaarden-Bakker, “Experimental Zooarchaeology,” in *Farm Life in a Carolingian Village*, pp. 107–17; *Diet and Crafts in Towns: The Evidence of Animal Remains from the Roman to the Post-Medieval Periods*, ed. D. Serjeantson and T. Waldron, BAR British Series 199 (Oxford, 1989); Jennifer Bourdillon, “Countryside and Town: The Animal Resources of Saxon Southampton,” in *Anglo-Saxon Settlements*, ed. Della Hooke (Oxford, 1988), pp. 177–95;

grazing resources and uses of the animals. Cattle and sheep required substantial amounts of grazing lands or hay and were thus likely to be favored by communities that had access to adequate pasturage or fodder from their arable. Pigs, goats, and poultry were foragers that could survive on more limited resources.

The following examples indicate some of the diversity of meat consumption patterns. Excavations at the Bavarian communities of Kelheim, Kirchheim, and Barbing reveal that the inhabitants of Kelheim and Kirchheim preferred cattle, while those at Barbing consumed more swine. The inhabitants of Kelheim and Kirchheim also ate substantial quantities of sheep, goat, and horse meat, while those at Barbing favored poultry over sheep and goats and consumed very little horseflesh. At Kirchheim, a purely rural settlement, people preferred the flesh of domestic animals and consumed the least game at .5 percent, while the pre-urban inhabitants of Kelheim, perhaps faced with a lack of readily available domestic animals, consumed 7 percent of their meat from game.⁴³ The households of Kootwijk preferred cattle by a wide margin over sheep, goats, and pigs; the lack of forest lands in the immediate vicinity of the village may explain the total absence of game in their food remains.⁴⁴ Among all identifiable bones at Wraysbury, some 41 percent were from cattle, 31 percent from swine, and 28 percent from sheep. The high percentage of sheep and their relative maturity at slaughter indicate a mixed wool-meat economy. Other less significant meats included chickens (*Gallus gallus*), geese (*Anser anser*), wild birds of various species, native red deer (*Cervus elaphus*), and roe deer (*Capreolus capreolus*).⁴⁵ Inhabitants of Southampton Hamwic preferred cattle but also consumed considerable quantities of sheep, with swine a distant third. As at Wraysbury, a mixed wool-meat economy seems to have prevailed. There was little interest in wild game of any sort.⁴⁶

Written sources confirm the importance of domestic animals. Titles 2–3 of the Salic Laws reveal a strong Frankish preference for swine and cattle.⁴⁷ *De villis* instructed stewards to maintain adequate shelter for the cows, sheep, pigs, and goats and to cull lame, but otherwise healthy, animals for food.⁴⁸ Each estate was

Brian Hesse and Paula Wapnish, *Animal Bone Archeology: From Objectives to Analysis* (Washington, D.C., 1985); Juliet Clutton-Brock, *Domesticated Animals from Early Times* (Austin, Tex., 1981); Frederick E. Zeuner, *A History of Domesticated Animals* (New York, 1963); S. Bökönyi, *History of Domestic Mammals in Central and Eastern Europe* (Budapest, 1974); Angela von den Driesch and Joachim Boessneck, "Haustierhaltung, Jagd, und Fischfang bei den Bajuwaren," in *Die Bajuwaren*, pp. 198–219. The above literature is a sample of currently available resources on animal husbandry. Bibliographies in the above should allow the interested reader to further pursue this increasingly important archaeological subfield. Poultry bones are likely to be underrepresented at almost all sites owing to their small size and fragility. The same is true, of course, for the smaller wild animals available in the forests near settlements.

⁴³ Von den Driesch and Boessneck, "Haustierhaltung," pp. 198–201.

⁴⁴ IJzereef, "Animal Remains," pp. 39–49.

⁴⁵ Astill and Lobb, "Excavation," pp. 113–17.

⁴⁶ Bourdillon, "Countryside and Town," pp. 180–82.

⁴⁷ *Pactus legis Salicae*, pp. 21–33, titles 2 and 3, and pp. 34–51, titles 4–9, cover offenses against other livestock and the fields. The laws are extremely detailed.

⁴⁸ *De villis*, p. 85 chap. 23: "In unaquaque villa nostra habeant iudices vaccaritias, porcaritias, berbicaritias, capraritias, hircaritias quantum plus potuerint et nullatenus sine hoc esse debent. . . . Et habeant, quando servierint ad carnes dandum, boves cloppos non languidos et vaccas sive caballos non scabiosos aut alia peccora non languida. Et ut diximus, pro hoc vaccaritias vel carrucas non minorent."

also to maintain an abundance of fowl, with the greater estates keeping at least 100 chickens and 30 geese, while the lesser estates were to maintain flocks of at least 50 chickens and 12 geese.⁴⁹ King Ina's hide rents demanded "2 full-grown cows or 10 wethers, 10 geese, 20 hens" annually from every ten hides.⁵⁰ Some tenants resident on the estates of St.-Remi of Reims supplied their clerical overlords with annual rents of livestock, including poultry, lambs, and pigs. Many tenants of St.-Germain-des-Prés had similar obligations.⁵¹

Meats and poultry were collectively the most important sources of high-quality complete protein available to early-medieval peoples.⁵² Their significant micronutrients included K, D,⁵³ B1, B2, niacin, B6, B12,⁵⁴ iron, and zinc.⁵⁵ Among the most nutrient-dense portions of all animals were organ meats such as kidneys, hearts, and livers. Unfortunately, there is little evidence concerning offal consumption. Marrow, the nutrient-rich material found in the cavities of bones, was certainly consumed by the inhabitants of Kootwijk, early Christian Ireland, and late Roman and early Anglo-Saxon England.⁵⁶ The sausages listed among the stores of Staffelsee and Annapes may well have contained offal.⁵⁷ Perhaps Romanized barbarians adopted the Roman enthusiasm for these delicacies.⁵⁸ In any case, offal constituted only a small fraction of the carcass weight of any animal, effectively limiting its consumption by the majority of a community's inhabitants.

The lack of refrigeration meant that all communities preserved meats through salting, smoking, or storing in fat. Fat could be used to cook and preserve cuts of meat, sausages, and poultry in the same manner that *comfits* are still made in rural France. Both the meats and the fats could be used to add savor to stews and beans.⁵⁹ Preservation would have enhanced sodium, fat, or carcinogen levels in meats, depending on the method used.

⁴⁹ *De villis*, p. 84 chap. 19: "Ad scuras nostras in villis capitaneis pullos habeant non minus C et aucas non minus XXX, ad mansioniles vero pullos habeant non minus L, aucas non minus quam XII."

⁵⁰ Attenborough, *Laws*, pp. 58–59.

⁵¹ *Polyptyque de Saint-Remi*, pp. 78, no. 77; 79, no. 2; 98, no. 6; and *Polyptyque de Saint-Germain-des-Prés*, 2, pp. 6, no. 42; 28, no. 121; 270, no. 50.

⁵² *Modern Nutrition*, appendix, table A-9a, "Values for the Digestibility of Protein in Man"; *Nährwerte*, pp. 10–16; *Food Values*, pp. 86–102.

⁵³ Michael F. Holick, "Vitamin D," in *Modern Nutrition*, pp. 308–10, 315–23. D is essential for the prevention of rickets.

⁵⁴ Herbert and Das, "Folic Acid and Vitamin B-12," pp. 411–21. B12 is essential for the prevention of anemia. It is found only in foods of animal origin. Pregnant and lactating women have substantially higher requirements for B12, and their diets are often deficient.

⁵⁵ Janet C. King and Carl L. Keen, "Zinc," in *Modern Nutrition*, pp. 215–28; *Nährwerte*, p. 74; *Food Values*, pp. 86–102. Zinc contributes to a number of functions related to growth. Deficiencies trigger retarded fetal growth, dwarfism, anorexia, and night blindness.

⁵⁶ Wijngaarden-Bakker, "Experimental Zooarcheology," pp. 106–14; McCormick, "Dairying and Beef Production," p. 256; and Maltby, "Animal Bones," pp. 128–33.

⁵⁷ *Brevium exempla*, pp. 252 and 254, chaps. 7 and 25; for the text, see n. 59, below.

⁵⁸ Ilaria Gozzini Giacosa, *A Taste of Ancient Rome*, trans. Anna Herklotz (Chicago, 1992), p. 87.

⁵⁹ *De villis*, p. 86, chap. 34: "Omnino praevidendum est cum omni diligentia, ut quicquid manibus laboraverint aut fecerint, id est lardum, siccamen, sulcia, niusaltus . . ."; and *Brevium exempla*, p. 252, chap. 7: "De lardo baccones XX pariter cum minutis, unctos XXVII"; and title 25, p. 254: "De censu: butyrum modium I; lartum de praeterito anno baccones X, noves baccones CC cum minucia et unctis." On traditional home-preserving methods for meats, see Jane Grigson, *Charcuterie and French Pork Cookery* (New York, 1970), pp. 171–218, 267–336.

Fish provided a secondary source of high-quality complete protein and shared the other nutritional pluses of meat.⁶⁰ Archaeological evidence for fish eating is limited by the typically rapid decomposition of fish bones in certain soils, with the result that fish consumption is likely to be underrepresented in faunal remains.⁶¹ Communities in close proximity to lakes, rivers, or marine waters certainly took advantage of the availability of fish. For example, the inhabitants of Wraysbury enjoyed a wide range of fish, with a marked preference for eel (*Anguilla anguilla*). They consumed lesser amounts of preserved herring (*Clupeidae sp.*), trout (*Salmo trutta*), salmon (*Salmo salar*), pike (*Esox lucius*), and smaller fishes.⁶² Laws protected nets and provided for the stocking of ponds.⁶³ Monastic rules and the calendar of fasts restricted or prohibited meat eating and created demands for fish.⁶⁴ A 785 capitulary issued for Saxony punished the breaking of the Lenten fast with death, unless necessity of hunger compelled the consumption of meat. The eating of fish on certain days was thus one possible means of imposing Frankish ways upon newly conquered and Christianized lands.⁶⁵

Animal by-products such as eggs and cheese were another category of foodstuffs common to all communities raising poultry and other livestock. *De villis* even allowed eggs to be used as a subtle form of bribery by including them among the goods that could legitimately be accepted by the royal stewards as gifts from their tenants.⁶⁶ Stewards were to make periodic inspection of the egg supply and to collect egg dues (along with a host of other foodstuffs) each Christmas.⁶⁷ Clerical estates also demanded substantial numbers of eggs from their tenants.⁶⁸ It is possible to preserve eggs through salt pickling, but evidence for this practice is lacking.

⁶⁰ *Nährwerte*, pp. 6–10; *Food Values*, pp. 49–56.

⁶¹ Von den Driesch and Boessneck, “Haustierhaltung,” p. 203.

⁶² Astill and Lobb, “Excavation,” pp. 119–20.

⁶³ *De villis*, p. 85, chap. 21: “Vivarios in curtes nostras unusquisque iudex ubi antea fuerunt habeat, et si augeri potest, augeat; et ubi antea non fuerunt et modo esse possunt, noviter fiant”; p. 89, chap. 65: “Ut pisces de wiiariis nostris venundentur et alii mittantur in locum, ita ut pisces semper habeant; tamen quando nos in villas non venimus, tunc fiant venundati et ipsos ad nostrum profectum iudices nostri conlucrare faciant”; also see *Pactus legis Salicae*, pp. 197–208, title 27.27–28.

⁶⁴ *The Old English Version of the Enlarged Rule of Chrodegang together with the Latin Original*, ed. Arthur S. Napier (London, 1916), p. 13, chap. 6: “Illo tempore quando quadragessimalem uitam debent ducere, tunc ad sextam inter duos clericos portionem de formatico, et cibaria alia accipiant; et si pisces habuerint, aut legumen, aut aliud aliquid, addatur et tertium . . .”; *RB 1980: The Rule of St. Benedict*, ed. Timothy Fry, O.S.B. (Collegeville, Minn., 1981), p. 238, chap. 39: “Carnium vero quadrupedum omnimodo ab omnibus abstinenceur comestio, praeter omnino debiles aegrotos”; and Caroline Walker Bynum, *Holy Feast and Holy Fast: The Religious Significance of Food to Medieval Women* (Berkeley, Calif., 1987), pp. 32–42.

⁶⁵ MGH Capit 1:68, chap. 4: “Si quis sanctum quadragensimale ieiunium pro despectu christianitatis contempserit et carnem comederit, morte moriatur; sed tamen consideretur a sacerdote, ne forte causa necessitatis hoc cuilibet proveniat ut carnem commedat.”

⁶⁶ *De villis*, p. 83, chap. 3: “Ut non praesumant iudices nostram familiam in eorum servitium ponere, . . . et neque ulla dona ab ipsis accipiant, non caballum non bovem non vaccam non porcum non berbicem non porcellum non agnellum nec aliam causam, nisi buticulas et ortum, poma, pullos et ova.”

⁶⁷ *De villis*, p. 84, chap. 20: “Unusquisque iudex fructa semper habundanter faciat omni anno ad curtem venire, excepto visitationes eorum per vices tres aut quattuor seu amplius dirigant”; and p. 89, chap. 62: “. . . quid de cervisa, de vino novo et vetere, de annona nova et vetere, quid de pullis et ovis vel anseribus id est aucas. . . .”

⁶⁸ See *Polyptyque de Saint-Remi*, where overseers frequently collected chickens and eggs at a 1:5

The food rents of King Ina included an annual demand for one cheese per hide; the size of the cheese is not stipulated.⁶⁹ The monks of St.-Germain-des-Prés annually collected 12,000 kilograms of cheese from their tenants.⁷⁰ Charlemagne required a bishop to supply two cartloads of a soft rinded cheese annually to the palace at Aachen after sampling it at the bishop's table.⁷¹ The monastery of Staf-felsee possessed 40 cheeses in its storehouse around 800, while the royal fisc at Annapes had 1,290 kilograms of cheese on hand.⁷² Cheese was made from goats', sheep's, and cows' milk; it offered much better keeping qualities than fresh raw milk, and its production created a by-product—whey—that could be used to make either a soft cheese resembling our modern ricotta or drunk as a beverage.⁷³ Like fish, cheese was an important component of the monastic diet; it might also be in high demand by observant laity during periods of fasting, since the “mouth feel” of cheese (created by its fat content) can alleviate the desire for the somewhat similar characteristic in meat. Even communities free of burdensome rents and demanding overlords would have produced substantial amounts of cheese as the best means of preserving milk from their animals.

Both eggs and cheese were significant sources of essential nutrients. Eggs produce the most balanced form available of dietary protein,⁷⁴ while cheeses and other milk products supply abundant calcium,⁷⁵ significant amounts of phosphorus, copper,⁷⁶ iodine,⁷⁷ zinc, and vitamins A,⁷⁸ K, B2, and B12.

It is difficult to assess the role of most vegetables and fruits. *De villis* lists

ratio: pp. 3, no. 2; 7, no. 2, “Pullos III, ova XV”; 16, no. 12, “pullam I, ova V.” Pp. 27, nos. 16 and 17; 28, nos. 23 and 24; and 29, no. 32, indicate that extra eggs and poultry were collected for major feasts and holidays such as St. Martin's Day, Easter, and Christmas. Peasants of St.-Germain-des-Prés were also expected to provide abundant eggs and poultry, as were the tenants mentioned in *Lex Baiuvariorum* 1.13.

⁶⁹ Attenborough, *Laws*, no. 70, pp. 58–59.

⁷⁰ Riché, *Daily Life*, p. 172.

⁷¹ *Monachi Sangallensis de gestis Karoli Imperatoris libri II*, MGH SS 2:737: “Omnibus annis duas carradas talibus caseis plenas ad Aquasgrani mihi dirigere ne praetermittas.”

⁷² *Brevium exempla*, p. 252, chap. 7: “formaticos XL”; p. 254, chap. 25: “formaticos de anno presentis pensas XXXXIII.” Rouche, “La faim,” p. 304, calculates one *pensa* as 30 kilograms.

⁷³ Hagen, *Handbook*, pp. 19–23; interesting comparative evidence from Ireland is cited by McCormick, “Dairying and Beef Production,” pp. 253–54, where he lists a number of cheeses mentioned in Irish literary sources.

⁷⁴ *Modern Nutrition*, appendix, table A-9a.

⁷⁵ Allen and Wood, “Calcium and Phosphorus,” pp. 152–53; *Nährwerte*, pp. 61–62; *Food Values*, pp. 11–13. Calcium is essential for the coagulation of blood, the building of bone and bone mass, the maintenance of cellular membranes, and proper hormone secretion. It must be maintained in proper balance with phosphorus. Calcium was available elsewhere in the food supply, in greens such as spinach, kohlrabi, and leeks, but cheese constituted the only major year-round source.

⁷⁶ Judith R. Turmlund, “Copper,” in *Modern Nutrition*, pp. 231–39; *Nährwerte*, pp. 71–72; *Food Values*, pp. 11–13. Copper regulates skeletal mineralization, connective tissue synthesis, melanin pigmentation, cholesterol metabolism, immune and cardiac functions, and glucose balance. Deficiency leads to skeletal demineralization and brain tissue degeneration.

⁷⁷ Basil S. Hetzel and Graeme A. Clugston, “Iodine,” in *Modern Nutrition*, pp. 252–60. Iodine regulates thyroid function; deficiencies produce goiters and mental retardation.

⁷⁸ James Allen Olson, “Vitamin A, Retinoids, and Carotenoids,” in *Modern Nutrition*, pp. 293–301; *Nährwerte*, p. 39; *Food Values*, pp. 11–13. Vitamin A promotes vision and organ function, especially reproductive organ function. Deficiencies create night blindness and dermatological disorders.

those plants regarded as desirable for a well-stocked palace garden.⁷⁹ There were root vegetables such as burdock,⁸⁰ beets,⁸¹ carrots,⁸² turnips,⁸³ and parsnips.⁸⁴ All could be dug and stored in a cellar or left in the ground until needed. The *brassicae* included the highly nutritious cabbage,⁸⁵ which could be made into sauerkraut, and kohlrabi.⁸⁶ A number of cold-tolerant greens, such as lettuce,⁸⁷ arugula,⁸⁸ garden-cress,⁸⁹ parsley,⁹⁰ endive,⁹¹ and lovage,⁹² could be grown through a mild winter to provide fresh greens well into spring. They were probably boiled or added to beans and meat stews, although it is possible that they were treated as salad greens.⁹³ The allium family included leeks,⁹⁴ chives,⁹⁵ onions,⁹⁶ shallots,⁹⁷ and garlic.⁹⁸ Other vegetables included members of the complex family of cucumbers,⁹⁹ gourds,¹⁰⁰ and squashes,¹⁰¹ as well as celery,¹⁰² fen-

⁷⁹ *De villis*, pp. 90–91, chap. 70. The footnotes list the Latin and German names of the plants according to nineteenth-century classifications. In some instances Latin names have changed through reclassification, and I have amended where necessary to reflect current nomenclature. In the interest of clarity, notes 81–114 below give the name listed in *De villis* followed by the current Latin name. Michael Wright, *The Complete Book of Gardening* (New York, 1978); and Lesley Bremness, *The Complete Book of Herbs* (New York, 1988), both provide Latin nomenclature as well as practical cultivation information often lacking in the more scientifically oriented botanical textbooks. A useful translation of the capitulary is “Capitulare de villis,” in *Introduction to Contemporary Civilization in the West*, 2nd ed. (New York, 1954), pp. 5–13.

⁸⁰ “Parduna” in *De villis*; the footnotes list no identification. The translation cited above referred to this plant as burdock. *The Herbal or General History of Plants; The Complete 1633 Edition as Revised and Enlarged by Thomas Johnson*, facsimile ed. (New York, 1975), pp. 809–10, notes that “The great Burre is called . . . in Latine, *Perdonata*, *perdontia*, and *Arctium*”; Geri Harrington, *Grow Your Own Chinese Vegetables* (Pownal, Vt., 1984), identifies it as *Arctium lappa*. It is now primarily consumed in Asian countries.

⁸¹ “Betas,” *Beta vulgaris conditiva*.

⁸² “Carvitas,” *Daucus carota*.

⁸³ “Rutam,” *Brassica rapa rapa*.

⁸⁴ “Pastenacas,” *Pastinaca sativa*.

⁸⁵ “Caulos,” *Brassica oleracea*.

⁸⁶ “Ravacaulos,” *Brassica oleracea gongylodes*.

⁸⁷ “Lactucas,” *Lactuca sativa*.

⁸⁸ “Eruca alba,” *Eruca sativa*.

⁸⁹ “Nasturtium,” *Lepidium sativum*.

⁹⁰ “Petresilinum,” *Petroselinum crispum*.

⁹¹ “Intubas,” *Cichorium intybus*.

⁹² “Levisticum,” *Levisticum officinale*.

⁹³ Peasant populations in contemporary Europe still add many of these greens to soups or stews; the Apulian regional speciality “fave e cicoria” is a mixture of favas and endive seasoned with olive oil. The use of spring greens to create a Lenten pot liquor or vegetarian broth is common in Italian, Greek, and German cuisines.

⁹⁴ “Porros,” *Allium porrum*.

⁹⁵ “Britlas,” *Allium schoenoprasum*.

⁹⁶ “Uniones,” *Allium cepa*.

⁹⁷ “Ascalonicas,” *Allium ascalonicum*.

⁹⁸ “Alia,” *Allium sativum*.

⁹⁹ “Cucumeres,” *Cucumis sativus*. The cucumber-squash-gourd family is often difficult to identify as to exact species and subspecies.

¹⁰⁰ “Pepones,” *Cucumis melo*; these may be melons or gourdlike squash.

¹⁰¹ “Cucurbitas,” *Cucurbita pepo*. These plants are similar to summer squash or zucchini/marrows.

¹⁰² “Apium,” *Apium graveolens*.

nel,¹⁰³ and radishes.¹⁰⁴ Among the fruits were apples,¹⁰⁵ pears,¹⁰⁶ plums,¹⁰⁷ medlars,¹⁰⁸ peaches,¹⁰⁹ quinces,¹¹⁰ mulberries,¹¹¹ figs,¹¹² and cherries.¹¹³ Many of these fruits could be dried, pickled in vinegar, or turned into wine. A variety of apple and pear strains, including those with keeping and forcing qualities, were grown.¹¹⁴ Such a garden would have provided year-round nourishment from either fresh or preserved fruits and vegetables.

However, two surviving inventories suggest that even gardens attached to wealthy royal estates lacked such an abundant variety of plants. The garden at Annapes contained parsley, celery, turnips, leeks, garlic, shallots, onions, cabbages, and kohlrabi. Fruits included pears, apples, medlars, peaches, mulberries, and quinces. A second garden contained celery, leeks, cabbages, beets, onions, garlic and shallots, apples, pears, medlars, peaches, plums, mulberries, quinces, and cherries.¹¹⁵ While fruits appear to compare favorably with the ideal garden of *De villis*, the vegetables reveal a lack of variety that must have provided for a somewhat monotonous diet heavily oriented to members of the cabbage and onion families. Nor does archaeology aid in clarifying the picture since seeds are rarely preserved unless carbonized. Turnip seeds found at Kootwijk may represent a weed or a cultivated plant.¹¹⁶ Vegetables and fruits supplementing the grains, meats, and legumes provided carbohydrates, dietary fiber, and traces of most essential nutrients.¹¹⁷ They were the primary sources of folic acid and vitamin C in the diet.¹¹⁸

Wine and beer supplied carbohydrates and alcohol and preserved grains and fruits that might otherwise be lost to spoilage.¹¹⁹ The Romans established vine-

¹⁰³ "Feniculum," *Foeniculum vulgare*. The plant yields feathery leaves and licorice-flavored seeds for seasoning or medicinal purposes and a bulblike base that can be stewed or consumed raw.

¹⁰⁴ "Radices," *Raphanus sativus*.

¹⁰⁵ "Pomarios," *Malus sylvestris*.

¹⁰⁶ "Pirarios," *Pyrus communis*.

¹⁰⁷ "Prunarios," *Prunus domestica*.

¹⁰⁸ "Mespilarios," *Mespilus germanica*.

¹⁰⁹ "Persicarios," *Prunus persica*.

¹¹⁰ "Cotoniarios," *Cydonia oblonga*.

¹¹¹ "Morarios," *Morus nigra*.

¹¹² "Ficus," *Ficus carica*.

¹¹³ "Ceresarios," *Prunus cerasus*.

¹¹⁴ "Malorum nomina: gozmaringa, geroldinga, crevedella, spirauca, dulcia, acriores, omnia servatoria; et subito comessura; primitiva. Perariciis servatoria trium et quartum genus, dulciores et cocciore et serotina." Individual types or strains can no longer be identified.

¹¹⁵ *Brevium exempla*, p. 255, chap. 29; and p. 256, chap. 37.

¹¹⁶ Pals, "Reconstruction of Landscape," p. 69.

¹¹⁷ Significant sources of nutrients include the following: A in cresses and carrots; K in lettuces, carrots, and cabbages; B6 in cabbages and leeks; folic acid in cucumbers, squashes, endives, beets, kohlrabies, carrots, turnips, and leeks; C in cabbages, kohlrabies, leeks, and turnips; potassium in celery, beets, kohlrabies, and radishes; calcium in celery, kohlrabies, and leeks; magnesium in kohlrabies and beets; iron in some squashes; and iodine in carrots (summarized from *Nährwerte*, pp. 38–74). The fruits were not as nutrient-dense as many vegetables but did supply additional traces of most of the nutrients mentioned above.

¹¹⁸ Robert A. Jacob, "Vitamin C," in *Modern Nutrition*, pp. 434–46; *Food Values*, pp. 63–69, 136–48; *Nährwerte*, pp. 22–28. C prevents scurvy and aids in the absorption of iron.

¹¹⁹ *Nährwerte*, p. 30; *Food Values*, p. 4. The process of fermentation and the resultant alcohol made reasonably long storage possible. Charlie Papazian, *The New Complete Joy of Home Brewing*, rev.

yards north of the Alps by the later first century A.D., and beer had been known since Mesopotamian times. The Bavarians, at least, brewed their beer with hops by the eighth century.¹²⁰ Much land since converted to other crops was used for grape growing in the early Middle Ages.¹²¹ Beverage preference depended upon local availability or the resources to acquire “imported” wine in areas where grapes would not grow. In areas such as Reims, viniculture and wine figured into peasant obligations.¹²²

Fats and oils supplied caloric density for energy.¹²³ The temperate zones were not suited to the cultivation of the olive, which grew only in the Mediterranean lands.¹²⁴ The inhabitants of more northerly regions made do with various animal fats, which functioned both as preservatives and as foodstuffs in their own right. Annapes and Staffelsee kept butter and pork fat among their stores; here again such goods figured into the peasants’ annual burdens. *De villis* also stipulated the annual production and collection of sheep fat and beef tallow.¹²⁵ King Ina collected butter as one form of hide rent during the seventh century.¹²⁶

Nuts were a valuable item within the early-medieval diet. They grew wild in the forests and were cultivated in some gardens. Nuts, like grains and legumes, possessed good storage qualities and therefore formed part of the emergency food stores of all communities. The orchards of royal estates grew walnuts, almonds, hazelnuts or filberts, and the starchy chestnuts.¹²⁷ Nuts, with the exception of chestnuts, were an excellent source of protein and fats in the diet.¹²⁸

The most problematic category of foodstuffs in the medieval diet was wild plants such as mushrooms and greens. Boletes, chanterelles, morels, and common field mushrooms contained significant levels of protein, vitamins D, K, B1, B2, niacin, folic acid, potassium, phosphorus, iron, iodine, and copper.¹²⁹ Their nutritional value was well worth the labor of hunting them, but the toxicity of some varieties might encourage a cautious eater to ignore this foodstuff. Wild greens were doubtless consumed, as they still are today in peasant communities through-

ed. (New York, 1991), provides recipes that allow a reasonable approximation of early-medieval brewing.

¹²⁰ Küster, “Umwelt und Pflanzenanbau,” p. 187. Joachim von Elbe, *Roman Germany: A Guide to Sites and Museums*, rev. ed. (Mainz, 1977), pp. 62, 287, 302–4, considers Roman viniculture in Gaul and Germany. Also see Solomon H. Katz and Fritz Maytag, “Brewing an Ancient Beer,” *Archaeology* 44 (1991), 24–33.

¹²¹ Küster, “Umwelt und Pflanzenanbau,” p. 187.

¹²² *Polyptyque de Saint-Remi*, pp. 2, no. 16; 11, no. 4; 14, nos. 2, 4, and 6.

¹²³ As every dieter now knows, fats contain the most energy, at nine calories per gram, with proteins and carbohydrates each supplying four calories per gram.

¹²⁴ N. J. G. Pounds, *An Historical Geography of Europe* (Cambridge, Eng., 1990), pp. 38–39.

¹²⁵ *De villis*, p. 86, chap. 34: “id est lardum”; p. 87, chap. 44: “butirum”; also see *Brevium exempla*, p. 252, chap. 7, and p. 254, chap. 25.

¹²⁶ Attenborough, *Laws*, pp. 58–59.

¹²⁷ *De villis*, pp. 90–91, chap. 70: walnuts: “nucarios,” *Juglans regia*; almonds: “amandalarios,” *Prunus amygdalus*; hazelnuts or filberts: “avellanarios,” *Corylus avellana* or *Corylus maxima*; chestnuts: “castanearios,” *Castanea sativa*; and see also *Brevium exempla*, p. 255, chap. 29, and p. 256, chap. 38.

¹²⁸ *Nährwerte*, pp. 20–22; *Food Values*, pp. 107–8.

¹²⁹ *Nährwerte*, pp. 24–25, 41, 44, 46, 48, 49, 52, 60, 63, 67, 68, and 72.

out Europe.¹³⁰ Seeds found in wells at Kootwijk indicate that this community, at least, harvested several wild plants: elderberry (*Sambucus nigra*), wild strawberry (*Fragaria vesca*), rose (*Rosa sp.*), raspberry (*Rubus idaeus*), and blackberry (*Rubus sect. rubus*).¹³¹ Consumption of these plants would certainly have improved nutritional levels in the community, since berries and rose hips are generally high in vitamin C.¹³² Such a nutritional boost would have been largely seasonal, however. The nutritional values of most wild plants have not, as yet, been adequately studied, so that any analysis of their significance in the diet remains purely speculative.

Honey, the only sweetener in the diet, could be harvested in the wild and from carefully guarded domestic hives. The harsh penalties assessed for theft of hives in the Salic Laws—equal to those for herd bulls—indicate the value placed on honey by early-medieval peoples.¹³³ Honey could be converted to the alcoholic beverage mead, but the difficulties of harvesting and production probably limited its consumption to the elite.¹³⁴ Salt, essential not only for regulating fluid balances in the body but for preserving foods, was produced through evaporation in a salt vessel or *patella*. It came both from coastal regions and from the mines of salt-rich regions such as those around Salzburg.¹³⁵

The above survey of theoretically available foods suggests that early-medieval populations could obtain adequate nutrition from the foodstuffs that are known to have been cultivated or utilized. Their hypothetical diet was marginally adequate by the standard United States Department of Agriculture food pyramid, although it seems to have been inadequate according to the currently fashionable Mediterranean model.¹³⁶ It contained sufficient carbohydrates, proteins, and fats and minimally acceptable levels of the necessary vitamins and minerals. Several weaknesses are clearly visible. Vitamin C-rich foods were in short supply. Plants such as peppers, tomatoes, and potatoes were unavailable. Citruses such as lemons and oranges could be cultivated only in the Mediterranean lands. Some *brassicae* such as cabbage could provide adequate vitamin C in both their fresh and pickled

¹³⁰ Patience Gray, *Honey from a Weed: Fasting and Feasting in Tuscany, Catalonia, the Cyclades, and Apulia* (New York, 1987), pp. 189–204, examines the persistence of wild plants in the diets of European peasants living in Mediterranean lands.

¹³¹ Pals, “Reconstruction of Landscape,” p. 69.

¹³² *Food Values*, pp. 63–69; and *Nährwerte*, pp. 26–29.

¹³³ *Pactus legis Salicae*, p. 43, title 8.1: “Si quis unam apem hoc est unum uasum deintro clauem furauerit et tectum super habuerit cui fuerit adprobatum, mallobergo antedio olechardis hoc est, MDCCC denarios qui faciunt solidos XLV culpabilis iudicetur excepto capitale et dilatura.”

¹³⁴ Karl Brunner, “Wovon lebte der Mensch? Zur Wirtschaftsgeschichte der Baiern im Frühmittelalter,” in *Die Bajuwaren*, p. 195. Slicher van Bath, *Agrarian History*, p. 183, gives a thirteenth-century production level of nine liters annually per hive.

¹³⁵ *Diet and Health: Implications for Reducing Chronic Disease* (Washington, D.C., 1989), pp. 413–18; Heinrich Wandewitz, *Studien zum mittelalterlichen Salzwesen in Bayern* (Munich, 1984), provides a comprehensive overview of Salzburg’s role in salt production and trade throughout the Middle Ages.

¹³⁶ Cheryl Achterberg, Elaine McDonnell, and Robin Bagby, “How to Put the Food Guide Pyramid into Practice,” *Journal of the American Dietetic Association* 194 (1994), 1030–35; Nancy Harmon Jenkins, *The Mediterranean Diet* (New York, 1994), pp. 477–89, provides a summary of the Mediterranean diet “pyramid.”

forms provided the intake of them was substantial.¹³⁷ Another complication may have been excessive fiber. An average minimum level for most people, based on the consumption of 500 grams of whole-grain bread and 100 grams of legumes daily, was around 45–60 grams per day.¹³⁸ Such levels could have contributed to malnutrition among the elderly, the young, and pregnant and lactating women by blocking proper absorption of micronutrients.¹³⁹ Populations that favored pastoralism over arable agriculture may have lacked adequate intakes of the complex carbohydrates found in grains, although their protein levels were probably more than adequate. But did people routinely consume, on a daily basis, a balanced and nutritious diet? Many impediments existed along the road to good nutrition.

The first serious problem was the nature of agricultural productivity. Monastic rations for religious, their guests, and their servants do seemingly present a picture of caloric abundance. The earliest guidelines were relatively modest. Benedict of Nursia deemed 1 pound (the Roman pound of 327 grams) of bread per day per monk adequate. Each monk was allowed two meals daily in summer, and one in winter, and could choose from two cooked dishes plus an additional dish of seasonal fruits or vegetables. The allotment of wine was approximately .5–1 liter. Rations were increased if the heat or the workload justified it.¹⁴⁰ By the early Carolingian era such meager rations were found to be unacceptable in the cooler northern climates. An Anglo-Saxon version of Chrodegang of Metz's rule allowed 1.5–2 kilograms per day of bread per monk as well as meat and vegetable dishes.¹⁴¹ Rouche's dual analysis of a number of Carolingian rules and the various food rents and dues collected by monasteries from their peasants led him to conclude that the average daily rations for eighth- and ninth-century religious were extremely generous. They included 1.78–2 kilograms of bread, 1.55 liters of beer or wine, 90–110 grams of cheese, and 230 grams of legume puree per monk. Nuns' rations allocated lesser amounts of all foodstuffs: 1.44 kilograms of bread, 1.38 liters of wine or beer, 70 grams of cheese, and 133 grams of pureed legumes. Lay rations presented a greater diversity of appropriate amounts: 360–1,700 grams of bread, .570–1.45 liters of wine, .57–2.3 liters of beer, 35–102 grams of cheese, 218–362 grams of legumes, and 102–410 grams of fat and/or

¹³⁷ On vitamin C availability, see *Nährwerte*, pp. 57–58, and *Food Values*, pp. 62–69, 136–48.

¹³⁸ Such levels are the equivalent of consuming 441–588 grams of Nabisco's Shredded Wheat per day (a 15.5–21 ounce box). The author does not recommend reader experimentation.

¹³⁹ Schneeman and Tietyan, "Dietary Fiber," p. 97; and *Nährwerte*, pp. 18, 20, 22–25. Excessive fiber—"acutely higher" than 35 grams per day—may leach nutrients from the gastrointestinal tract.

¹⁴⁰ *RB 1980*, pp. 238–40, chaps. 39–40: "Sufficere credimus ad refectonem cotidianam tam sextae quam nonae, omnibus mensis, cocta duo pulmentaria, propter diversorum infirmitatibus. . . . Ergo duo pulmentaria cocta fratribus omnibus sufficiant et, si fuerit unde poma aut nascentia leguminum, addatur et tertium. Panis libra una propensa sufficiat in die. . . . credimus heminam vini per singulos sufficere per diem. . . . Quod si aut loci necessitas vel labor aut ardor aestatis amplius poposcerit, in arbitrio prioris consistat."

¹⁴¹ *Rule of Chrodegang*, p. 13, chap. 6: "Quando clerus una aut bina uice in die reficit, accipiat a minore usque ad maximum IIII libras panis; et quando bis in die reficit, pulmentum uero ad sextam, unam ministrationem de carne inter duos, et cibaria alia una accipient; et si cibaria non habent, tunc duas ministrationes de carne habeant."

meat. The rations were increased for holidays.¹⁴² Could early-medieval agriculture sustain these ration levels on a year-in, year-out basis? And if such levels were sustainable, what is the likelihood that people actually consumed these amounts?

No domestic animal or cultivated plant produced the yields available from today's genetically engineered livestock and selectively bred hybrid crops. Chickens were generally smaller and produced smaller and fewer eggs, probably in the range of 50–100 eggs per year.¹⁴³ Domestic livestock was overall 40–60 percent smaller than today's breeds.¹⁴⁴ Smaller animals routinely yield less meat to waste ratios than larger animals. J. P. Pals estimates that an average medieval cow weighing 250 kilograms yielded 65 kilograms of meat, 31 kilograms of edible offal, and 25 kilograms of fat. An average pig of 60 kilograms yielded 21.6 kilograms of meat, 3.75 kilograms of edible offal, and 14.4 kilograms of fat. An average sheep weighing 30 kilograms yielded 7.8 kilograms of meat, 3.75 kilograms of edible offal, and 3 kilograms of fat.¹⁴⁵ Grazing requirements, however, were at roughly the same levels as those for today's larger animals: an average of 1.5–2 hectares per cow and .66–1.66 hectares per sheep. Cattle and sheep could also be fed the straw generated by grain. An average cow required 1,825–2,263 kilograms per year and a sheep about 170 kilograms.¹⁴⁶

¹⁴² Rouche, "The Early Middle Ages in the West," pp. 445–46, seems to summarize some of the data from "La faim" and reveals, perhaps unintentionally, the difficulties involved in converting metric measurements into pounds and ounces. See tables 1–5, pp. 305–11, in "La faim" for his original ration estimates, which are considerably higher in several instances than the figures reported in "The Early Middle Ages in the West."

¹⁴³ Slicher van Bath, *Agrarian History*, p. 183, notes that thirteenth-century chickens produced an average of 115 eggs per year. R. W. Phillips, "Increasing Output of Animal Production: Relative Potential of Specific Meat-Producing Animals," in *Man, Food and Nutrition: Strategies and Technological Measures for Alleviating the World Food Problem*, ed. Miloslav Rechcigl, Jr. (Cleveland, Ohio, 1973), p. 153, reports that native chickens in India produce only 40–60 eggs per year, while American layer breeds in 1970 generated an average of 220 eggs per chicken per year. Current improved strains have reached levels of as much as 400 eggs per year. Early-medieval averages likely fell somewhere between those of native Indian chickens and the thirteenth-century fowl. Fragile chicken bones are generally poorly represented among animal remains; see Astill and Lobb, "Excavation," pp. 116–17, and Jennie Coy, "The Provision of Fowls and Fish for Towns," in *Diet and Crafts in Towns*, pp. 29–36, who suggests that chickens were in the bantam and slightly larger range.

¹⁴⁴ Archaeological examination of animal remains throughout the temperate zone (including those found at Eastern European sites) reveals that the larger Roman animals were generally supplanted by smaller early-medieval animals and that the medieval period as a whole represents a time of decline in the size of all types of livestock. See von den Driesch and Boessneck, "Haustierhaltung," pp. 200–201; Pals, "Observations on the Economy," p. 120; Ijzereef, "The Animal Remains," pp. 41–49; Bökönyi, *History of Domestic Mammals*, pp. 77–87, 123–39, 177–89, 196–200, 215–25, 262–70, 292–96; Teichert, "Die Tierreste," pp. 46–64; Astill and Lobb, "Excavation," pp. 111–19; Barbara A. Noddle, "A Comparison of the Bones of Cattle, Sheep, and Pigs from Ten Iron Age and Romano-British Sites," in *Animals and Archaeology*, 4:110–22; Teichert, "Size Variation in Cattle," pp. 93–101; and Zeuner, *History*, pp. 65–66, 145–52, 169–98, 211–36, 240–44, 256–71, and 443–59.

¹⁴⁵ J. P. Pals, "Observations on the Economy of the Settlement," in *Farm Life in a Carolingian Village*, p. 120; and von den Driesch and Boessneck, "Haustierhaltung," pp. 200–201.

¹⁴⁶ Pals, "Observations on the Economy," pp. 121–22, examines various studies to arrive at figures of 1.5–2 hectares of grazing land per cow and .66–1.66 hectares per sheep. American practice (before the use of growth hormones and feedlot strategies) dictated 5 acres of grazing land per cow, a figure very close to 2 hectares. For earlier-twentieth-century American comparisons, the author draws upon twenty years of personal experience in rural upstate South Carolina, where many farmers still practiced

Milking yields were much lower than today. Lactation in medieval livestock resulted solely through the birth of young.¹⁴⁷ Ann Hagen, using the Kerry cattle of England as her model, suggests that medieval cattle produced between 681.6 and 1,135.8 liters annually.¹⁴⁸ Angela von den Driesch and Joachim Boessneck believe that south German cattle averaged 540–1,200 liters.¹⁴⁹ B. H. Slicher van Bath estimated that fourteenth-century English cattle produced only 540–647 liters.¹⁵⁰ All these figures include milk consumed by nursing calves, reducing milk available to humans by about one-fifth to one-fourth. Young animals generally had to be nursed at least one month before they could be safely weaned and put out to graze.¹⁵¹ Hagen's estimate that cattle were replaced on a five-year basis, so that only every fifth calf needed to be reared, may be too optimistic in the light of archaeological evidence suggesting that cattle and other meat animals were slaughtered at earlier ages.¹⁵² The "average cow" probably produced amounts closer to Slicher van Bath's estimates for the fourteenth century, meaning that some 405–517.6 liters of milk were available for human consumption in some form.

The milk yield from medieval sheep and goats was approximately one-tenth that of cows, so that they probably produced between 40.5 and 51.7 liters of milk per year. Modern "unimproved" breeds of goats and sheep still have routinely low yields of milk, averaging between .5 and 1 liter per day. The early-medieval yield for sheep and goats was no higher, and very likely much lower; as with cattle, some milk was always reserved by necessity for suckling the young.¹⁵³

Modern artisanal cheese making, the technique that corresponds most closely

small-scale animal-powered subsistence farming well into the 1960s. The following families and individuals contributed greatly to this paper: Mr. and Mrs. William Parker Roper, Mr. and Mrs. William Rayford Roper, Mr. and Mrs. John Skelton, Mr. and Mrs. Ford Brown, and Mrs. Carrie Day. A number of south German farmers (whose names I regret failing to gather) patiently answered my inquiries beginning as early as 1979. A special thanks to Herr Winkler, who generously answered my questions concerning the raising, slaughtering, and curing of animals for his restaurant in Franconia.

¹⁴⁷ McCormick, "Dairying and Beef Production," p. 254.

¹⁴⁸ Hagen, *Handbook*, p. 17.

¹⁴⁹ Von den Driesch and Boessneck, "Haustierhaltung," p. 199.

¹⁵⁰ Slicher van Bath, *Agrarian History*, pp. 182, 335.

¹⁵¹ See James R. Simpson, *The Economics of Livestock Systems in Developing Countries* (London, 1988), esp. chaps. 3–5, 7, and 11; and *The World of Pastoralism*, ed. John G. Galaty and Douglas L. Johnson (New York, 1990), esp. pp. 372–75, on the diversity of suckling and weaning practices for sheep. My informants—American and German—generally agree that one month would be a minimum for traditional practice.

¹⁵² Hagen, *Handbook*, p. 17; but see McCormick, "Dairying and Beef Production," pp. 255–61; Teicher, "Die Tierreste," pp. 61–63; Astill and Lobb, "Excavation," pp. 114–15; Noddle, "A Comparison," pp. 111–15; and von den Driesch and Boessneck, "Haustierhaltung," p. 199; all note that remains indicate that the age at which livestock was slaughtered tended to vary from community to community, depending on whether the animals were valued for hides and fleeces, meat, or milk. Ages at most sites appear to average somewhat below five years for cattle and around two–three years for sheep and pigs.

¹⁵³ Slicher van Bath, *Agrarian History*, p. 183; von den Driesch and Boessneck, "Haustierhaltung," pp. 199–201; and Galaty and Johnson, *The World of Pastoralism*, pp. 372–75. Yields vary depending on the breed. James Chatto and Wendy L. Martin, *A Kitchen in Corfu* (New York, 1987), pp. 162–63, note that the sheep of modern-day rural Corfu produce approximately .5–1 liter of milk per day for 4–5 months, a figure unlikely to be exceeded by early-medieval breeds.

to early-medieval production, requires 4.18 liters of milk per 500 grams of cheese.¹⁵⁴ Milk available for cheese production was limited by several factors other than the nursing of young. Some was drunk as a beverage or churned into butter—an expensive fat to produce, as between 18.9 and 35 liters of milk are required to produce 1 kilogram of butter.¹⁵⁵ Spoilage or contamination also accounted for moderate losses.

Early-medieval grain yields can never be more than very rough approximations. Irrigation was impractical, and pesticides and mineral fertilizer were unavailable, so that yields from good versus poor soils were more skewed than they would be today. Georges Duby felt average yields possibly fell into the 3:1–4:1 range but then pointed to the abysmally low harvests recorded for Annapes, Vitry, and Cyssoing as a caution against too generous an estimate.¹⁵⁶ Renée Doehaerd was more pessimistic in finding the 4:1 ratio excessively high.¹⁵⁷ Slicher van Bath concluded that medieval yields in general fell into the 3:1 range.¹⁵⁸ The most pessimistic estimate is that of Adriaan Verhulst, who believes that ninth- and tenth-century yields were no better than 2:1–3:1.¹⁵⁹

What do the ratios imply for real output? Estimates of actual levels of grain production tend to rely on extrapolation from known levels of production between the thirteenth and nineteenth centuries. There is general agreement that early-medieval output was lower than later production levels. Hansjörg Küster believes that south German output was around 600–800 kilograms per hectare, while Pals concludes that the marginal soils of Kootwijk were nevertheless capable of 800–1,000 kilograms per hectare.¹⁶⁰ E. A. Wrigley uses a baseline of 673.6 kilograms per hectare in discussing late-eighteenth-century English yields.¹⁶¹ Slicher von Bath's calculations for some thirteenth- and fourteenth-century estates at Oxford and Winchester found a low yield of 546 kilograms per hectare and a high yield of 824 kilograms per hectare.¹⁶² All these estimates represent gross amounts before the subtraction of the seed. The Oxford and Winchester records did include data on the amount of seed needed: after its extraction, the low yield was only 393 kilograms per hectare, while the high yield was 593.28 kilograms per hectare. If yields averaged 2:1, then the estimates above suggest that edible grain was in the range of 300–500 kilograms per hectare; at 3:1, in the range of

¹⁵⁴ Ricki and Robert Carroll, *Cheesemaking Made Easy* (Charlotte, Vt., 1982), pp. 27–28, 48–49.

¹⁵⁵ Slicher van Bath, *Agrarian History*, p. 285.

¹⁵⁶ Duby, *Rural Economy*, pp. 25–27.

¹⁵⁷ Doehaerd, *The Early Middle Ages in the West*, pp. 2–7.

¹⁵⁸ Slicher van Bath, *Agrarian History*, pp. 328–29.

¹⁵⁹ Adriaan Verhulst, "The 'Agricultural Revolution' of the Middle Ages Reconsidered," in *Law, Custom, and the Social Fabric in Medieval Europe: Essays in Honor of Bryce Lyon*, ed. Bernard S. Bachrach and David Nicholas (Kalamazoo, Mich., 1990), pp. 21–22.

¹⁶⁰ Küster, "Umwelt und Pflanzenanbau," pp. 188–89; and Pals, "Observations on the Economy," p. 119. All estimates and calculations are based on the metric system. All calculations are carried to the second decimal point. Only the final numbers are rounded to the nearest liter, hectare, or kilogram.

¹⁶¹ E. A. Wrigley, "Some Reflections on Corn Yields and Prices in Pre-industrial Economies," in *Famine, Disease, and the Social Order in Early Modern Society*, ed. John Walter and Roger Schofield (Cambridge, Eng., 1989), pp. 239–40.

¹⁶² Slicher van Bath, *Agrarian History*, p. 173. He notes that these figures should be used with caution.

400–666.66 kilograms per hectare. Such ranges probably mirror actual early-medieval reality better than more precise figures. A narrower limit is, however, more useful for estimating nutritional data. Averages based on the medieval estimates offers two baselines: a lower one of 364.33 kilograms per hectare and a higher of 597.75 kilograms per hectare. Straw averaged about 2.5 times times the gross grain weight, running from a low of about 1,365 kilograms per hectare to a high of 2,500 kilograms per hectare per year.¹⁶³ These admittedly speculative levels provide a theoretical base for evaluating the available grain supply.

Grain had three human uses: bread, beer, and gruel. Grain requirements for bread depend on the quality of the flour. A 500-gram 100 percent whole-grain loaf requires 390 grams of flour. However, an 80 percent extraction loaf of “white bread” requires 487.5 grams of flour.¹⁶⁴ If religious and lay elites consumed white bread, as Pierre Riché believes, they wasted much of the grain to produce this luxury foodstuff.¹⁶⁵ The basic artisanal processes for beer brewing have changed little over the centuries. A modern barley beer brewed directly from the grain in a manner approximating early-medieval technique requires around 71.94 grams of grain per liter of beer.¹⁶⁶ A thick gruel that can be spooned or scooped with bread requires ratios of about 5 parts water to 1 part grain, or about .3 kilograms of grain per liter of water.¹⁶⁷

Grape wine requires a minimum of 1,201.05 grams of grapes per liter of wine.¹⁶⁸ Wines and ciders made from other fruits require between 360.1 and 1,921.69 grams of fruit per liter.¹⁶⁹ Wines of all sorts were less efficient to produce than beer; they were also in demand as a luxury beverage among elites. Their value as an exchange commodity makes it likely that peasants drank beer even in wine-producing regions.

Legumes had yields similar to those of grains; they probably had the same approximate usable levels of 364.33 and 597.75 kilograms per hectare noted above.¹⁷⁰ Yields for vegetables other than grains are impossible to calculate. All forms of vegetables were certainly smaller than today’s high-yield hybrids. Fertilizer in the form of animal manure was certainly used, but the ratio of manure to the arable must have meant that some lands were thinly manured, if they received any attention at all.¹⁷¹

¹⁶³ Pals, “Observations on the Economy,” p. 119.

¹⁶⁴ David, *English Bread*, pp. 31 and 238. The nineteenth-century estimates of flour to bread weight ratios remain accurate today if the baker selects a stone-milled grain from an artisan mill. Medieval white bread was, of course, made from unbleached wheat flour and hence more beige than white.

¹⁶⁵ Riché, *Daily Life*, p. 172.

¹⁶⁶ Papazian, *Home Brewing*, explains the process and gives proportions as well as model recipes on pp. 248–318.

¹⁶⁷ Data obtained through personal experimentation with oats, barley, wheat, and spelt.

¹⁶⁸ W. H. T. Tayleur, *The Penguin Book of Home Brewing and Wine-Making* (Baltimore, 1973), p. 181, gives the basic proportions.

¹⁶⁹ Tayleur, *Home Brewing*, pp. 275–84.

¹⁷⁰ Slicher van Bath, *Agrarian History*, pp. 328–29.

¹⁷¹ Küster, “Umwelt und Pflanzenanbau,” pp. 188–89; Pals, “Observations on the Economy,” pp. 121–27; and Slicher van Bath, *Agrarian History*, pp. 254–62. Heavy manuring requires either abundant cattle or sheep; they in turn make heavy demands upon grazing lands or upon the fodder supply. The cyclical nature of the problem does not appear to have been solved by early-medieval farmers.

What might these hypothetical figures mean for the distribution of foods? The heavily exploited lands of the monastery of St.-Germain-des-Prés offers some insights. Abbot Irmion ordered a survey of revenues owed the monastery by its rent-paying tenants in the early ninth century. Only those people who owed rents were enumerated; the surveyors had no interest in the free residents of villages. Nor were they interested in private, nontaxed food production; household animal husbandry and kitchen plot cultivation are recorded only where they contributed such things as chickens and eggs to the rent of the households.¹⁷²

The numbers involved also pose difficulties. The religious community itself consisted of 120 monks, who were supported by a great host of tenants. The first editor of the document, B. Guérard, calculated totals of 2,788 households and 10,026 individuals on the collective estates.¹⁷³ David Herlihy counted only tenancies directly owing rents and services for land to arrive at a much lower figure of 1,742 households occupied by 4,188 males, 3,556 females, and 939 children. Both scholars noted that the manuscript lacked surveys of some tenancies and failed to account for the domestic servants or slaves. Guérard certainly counted some individuals twice, but Herlihy's figures probably exclude many people who were in fact dependent upon the estates in some way. Nevertheless, Herlihy's figures provide a useful departure point in that they identify tenants who had direct connections to the production of the estates.¹⁷⁴ The monastery owned between 36,505 and 39,352 hectares of land, of which some 22,129–23,855 hectares constituted the arable, 13,353.5–14,395 hectares were woodlands, 595.5–641.9 hectares served as pasturage and meadowlands, and 427–460.3 hectares were vineyards.¹⁷⁵

The combination of foodstuff production estimates, the numbers of persons receiving rations, and Rouche's reconstructed rations lists allows a very rough approximation of potential demands made on the estates and illustrates the potential difficulties of generating enough foodstuffs to feed the monks and their tenants. The annual rations for 120 monks required between 60,811 and 85,410 kilograms of grain for baking, 4,884 kilograms of grain for brewing beer, 32,955–

¹⁷² On the interpretation of this and other polyptychs, see Robert Fossier, *Polyptyques et censiers*, fasc. 28 in *Typologie des Sources du Moyen Age Occidental* (Turnhout, 1978), pp. 17–33 and 51–61; Doehaerd, *The Early Middle Ages in the West*, pp. 41–44, nn. 242–59; and David Herlihy, *Medieval Households* (Cambridge, Mass., 1985), pp. 62–78.

¹⁷³ *Polyptique de Saint-Germain-des-Prés*, 1:243.

¹⁷⁴ *Polyptique de Saint-Germain-des-Prés*, 1:6–11, 31–56, 182–87, and 231–53. Herlihy, *Medieval Households*, pp. 64 ff., discusses the demographic data of the polyptych as they apply to households.

¹⁷⁵ *Polyptique de Saint-Germain-des-Prés*, 1:244; Longnon revised Guérard's much lower figures in his edition of the inventory. F. L. Ganshof, "Manorial Organization in the Low Countries in the Seventh, Eighth, and Ninth Centuries," *Transactions of the Royal Historical Society*, 4th ser. (1949), 46, calculated the basic measurement of the *bonnier* as equal to 1.28 hectares, a figure very close to Longnon's. Philip Grierson, "The Identity of the Unnamed Fiscs in the *Brevium exempla ad describendas res ecclesiasticas et fiscales*," *Revue belge de philologie et d'histoire* 18 (1939), 443, felt that the *bonnier* was somewhat larger, at 1.38 hectares. DUBY, *Rural Economy*, p. 554, defines the *bonnier* as .89–1.41 hectares (2.2–3.5 acres). Passing references in various secondary studies seem to favor either the Longnon-Ganshof or the Grierson calculations. I have used both as the parameters for defining the size limits of the property holdings.

40,278 liters of milk for cheese, and 3,357 kilograms of legumes. If the monks drank wine instead of beer, they required 81,539 kilograms of grapes.

Lay rations, as Rouche noted, were more variable. The 7,744 adult tenants, consuming 100 percent whole-grain bread, needed 793,698–3,748,018 kilograms of grain for bread, 115,905–467,688 kilograms of grain for beer, 827,051–2,410,264 liters of milk for cheese, and 205,377–341,052 kilograms of legumes. It is impossible to determine if peasants abstained from meat on Fridays and during Lent or during the performance of penance; even if they kept Friday and Lenten observances and did 10 days of penance a year, they still consumed 211,690–850,911 kilograms of meat on the remaining 268 days.¹⁷⁶ The 939 juveniles can be calculated at the low end of the adult amounts: they needed 96,240 kilograms of grain for bread, 14,054 kilograms of grain for beer, 15,193 kilograms of legumes, 100,284 liters of milk for cheese, and 25,668 kilograms of meat.¹⁷⁷

To these base totals can be added another 10 percent to allow for underrepresented servants or slaves, guests and their retainers, and others resident in rent-paying households omitted from the survey. Total demands on food resources to meet the levels of the rations lists would thus be 1,194,132–4,857,924 kilograms of grain for brewing and baking, 1,056,320–2,805,909 liters of milk for cheese, 246,322–395,564 kilograms of legumes, and 261,094–964,237 kilograms of meat.

How much land and how many animals would this level of consumption require? Two theoretical models based on the above data are useful. A low level of production model assumes that grains and legumes were harvested at a 2:1 ratio for some 364.33 kilograms per hectare, with some 1,365 kilograms of straw per hectare; that cattle averaged 405 liters of milk; that sheep produced 40.5 liters of milk; that meat consumption was based (as archaeological evidence indicates) on a mixture of cattle, sheep, and swine for an average “animal” weight of 58.41 kilograms; that cattle and sheep were fed the residue from the harvest; and that the pasture lands were used for cattle, who needed 2 hectares per head, while pigs foraged in the forests. At low production levels, St.-Germain-des-Prés needed 3,954–14,419 hectares of arable under annual cultivation for grain and legumes, the milk from 2,608–6,928 cows or 26,082–68,281 sheep, and the meat of 4,470–16,508 animals. Meat- and milk-producing animals required all the available pasture and meadowlands together with the straw from 4,620.5–15,233 hectares of arable. Again, this assumes that pigs fended for themselves in the forests.

Food supplies were clearly constrained by low production levels. The lower end of the rations scale was feasible; a high consumption level would have required that 60–65 percent of the arable be under cultivation in a rotation system with at least two annual harvests. Pals, among others, points out that grain has a five-day harvesting window and that each peasant could have harvested no more than

¹⁷⁶ Bynum, *Holy Feast*, pp. 33–40, discusses the early history of fasting.

¹⁷⁷ Children, especially the very young, probably consumed lesser amounts of legumes than did adults. My calculations use the lower amount of legumes from nuns’ rations as the base for juvenile consumption.

.166–.25 hectares per day.¹⁷⁸ If every household enumerated by Herlihy averaged 1 hectare per day for the five days of harvest, they could at best gather only 8,710 hectares' worth of grain and hay in any one harvest. Meat and cheese levels were also problematic; better availability could have been achieved by reducing grain production and allowing more land to lie fallow for grazing. High consumption of meat and milk appears virtually impossible given the limitations on cultivation and harvesting of the arable. Extension of grazing lands at the expense of the forest was impractical, since woodlands supplied forage for pigs and humans, building materials, and fuel. The lower range of rations—360 grams of bread, 1 liter of beer, 35 grams of cheese, 77 grams of legumes, and 102 grams of mixed fat and meat—would be possible if estates consistently met my theoretical low production levels. However, at c. 1,986–2,138 calories, this diet was inadequate for peasants (or anyone) doing substantial manual labor.¹⁷⁹ Vegetables and fruits from kitchen gardens as well as foraged foods (with the exception of nuts) would have added vitamins and minerals but not substantial numbers of calories.

The high annual production model assumes grain and legume yields at 597.75 kilograms per hectare, that cows provided 517 liters of milk, that sheep provided 51.7 liters of milk, and that meat came from cattle, sheep, and swine at an average “animal” weight of 58.41 kilograms. Cattle grazing on the pastures required 1.5 hectares per cow, and, as above, the cattle and sheep were fed all fodder left from the grain harvest, while pigs foraged. Since it was theoretically possible to meet low-ration demands at the lower production levels, only high-ration demands need to be considered here. The monks, peasants, and guests needed 8,789 hectares of arable for grains and legumes, milk from 5,421 cows or 54,272 sheep, 16,507 animals for meat, and fodder from 6,818 to 7,109 hectares to feed all meat and milk animals. Labor would have been subject to the same constraints noted above, but consistent high-production levels theoretically would have allowed enough calories per worker to permit heavy labor demands.

An important question remains: did peasants (and monks) actually consume all the food suggested by rations lists? It is unlikely that they were able to do so. In the years since Rouche's essay on rations appeared, there has been much research on dietary fiber and health. Insoluble fiber, found primarily in grains and fruit and vegetable skins, cannot be digested by humans; it binds with water in the colon and is excreted. Soluble fiber, which is digestible, is mostly found in the pulp of fruits and vegetables. Two kilograms of whole-grain bread may contain as much as 200 grams of fiber, mostly of the insoluble type. The vegetables and fruits that supplemented the diet added another 16–30 grams per day. No studies thus far have examined the implications of such extraordinary levels of consumption, although one analysis of the Paleolithic diet suggests that humans can consume up to a maximum of about 150 grams of fiber per day—if most of that fiber is soluble.¹⁸⁰ Extrapolation from other studies suggests that severe flatulence and

¹⁷⁸ Pals, “Observations on the Economy,” p. 119, cites several efforts to determine human harvesting workload levels.

¹⁷⁹ For calorie amounts, see *Nährwerte*, pp. 4, 10, 12, 18, 20, and 30.

¹⁸⁰ S. Boyd Eaton, Marjorie Shostak, and Melvin Konner, *The Paleolithic Prescription* (New York, 1988), pp. 90–91. The authors' recommended “Paleolithic Diet” remains controversial.

abdominal cramping, coupled with chronic diarrhea and dehydration, would be the result of such levels of consumption.¹⁸¹ On comfort grounds alone, such a fiber intake seems unlikely.

While St.-Germain-des-Prés could theoretically produce enough foods to feed its monks and tenants, juggling the various demands of its large populations of peasants and animals might have been difficult. The density of animal and human populations were in a very delicate balance with the ability of early-medieval agriculture to sustain such food demands. St.-Germain-des-Prés, at a minimum, needed low production levels every year just to maintain itself at a survival level; good years yielded some surplus but by no means generated a full year's food supply for storage. The very size of the estates posed a problem for nutritional adequacy.

Another limiting factor may also have been at work: the siphoning off of production to meet the growing food demands of town dwellers unable to grow their own food supplies. Richard Hodges notes that food for the emerging emporia of the eighth and ninth centuries had to come from somewhere and that the most logical sources of supply would have been the large and well-managed royal or clerical estates.¹⁸² Such redistribution of foods was necessary for the continued expansion of proto-urban communities. It undoubtedly enhanced the income of landlords at the expense of the nutritional needs of their peasant populations. Apparent surpluses, then, may not have been actual surpluses after all.

Indeed, smaller communities might have found decent nutrition somewhat more feasible even in regions with marginal soils. The twenty households of Kootwijk successfully exploited a total land area of some 150 hectares through judiciously balancing stock raising, cultivation of their arable, and foraging for fruits and nuts. It was only in the tenth century that changing climate forced abandonment of the site.¹⁸³ Free settlements with access to the nascent emergent market communities of England and the northwestern Continent might also have fared better than the heavily exploited populations of great clerical and lay estates, since they could have sold or exchanged their surpluses for other foods without profits going to an overlord.¹⁸⁴ Communities along or near waterways and seas also had more nutritional options. Both Wraysbury and Hamwic had access to many varieties of fish and shellfish. On the negative side, independent communities might have lacked the protection of stored foods so assiduously collected on well-managed estates. The food rents imposed by King Ina, the Carolingian rulers, or the monks of St.-Germain-des-Prés might have been the most effective way to insure survival for most of the population during famines. Freedom from exploitation may have encouraged peasants to labor more heartily to create marketable surpluses, but the lack of markets in many thinly settled regions might have discouraged such

¹⁸¹ See bibliography in Schneeman and Tietyan, "Dietary Fiber," pp. 98–99.

¹⁸² Hodges, *Dark Age Economics*, pp. 136–50.

¹⁸³ Pals, "Observations on the Economy," pp. 119–23.

¹⁸⁴ Hodges, *Dark Age Economics*, pp. 130–50, examines the implications of emergent emporia on food production and consumption.

initiatives.¹⁸⁵ The marketplaces of Europe were still in their infancy or early adolescence during the sixth–ninth centuries, so that a general focus on self-sufficiency was less an option than a necessity.

All communities, moreover, were subject to pressures beyond their control at some point in their history. The most serious pressures were created by “acts of God,” the damage caused by weather, plague, and pestilences. Evidence from both early-medieval chronicles and modern climatological studies indicate that there was a general cooling off in the temperate lands between A.D. 400 and 900. Overall, the average mean temperature may have dropped by as much as two to three degrees centigrade.¹⁸⁶ This would have shortened growing seasons throughout the temperate zone and may in itself be adequate to explain much of the low levels of productivity. Some other patterns can be discerned. Cool summers were especially significant between 500 and 700 and during the 800s, while cold winters were more common from the seventh to the tenth centuries. Although summers were warmer during the seventh, eighth, and tenth centuries, they also tended to be dry and were often coupled with cold winters. The century between 764 and 860 produced some six to ten very severe winters marked by the freezing of the great rivers.¹⁸⁷ Both the long-term shift in the climate and the short-term fluctuations in local microclimates created food crises. It is surely significant that the major and minor chronicles for the years 555–1001 mention only one year—722—of *magna fertilitas*.¹⁸⁸

Most shortages were local in nature, constituting brief food scarcities rather than long-term famines. Episodes of mass starvation were rare, but most people probably experienced shortages at some point during their lifetime. Such patterns were common in early-medieval subsistence communities, as they were in most pre-industrial agricultural environments, in part because attempts at self-sufficiency made them more susceptible to local or regional problems.¹⁸⁹ Whether short-term or long-term, the miseries of hunger were very real.

It is sufficient to look at a few crises to show the ways in which climate could affect health. An account from the *Saxon Annals* for 820 illustrates how local

¹⁸⁵ Hodges, *Dark Age Economics*, pp. 151–61, points to the ninth century as the one in which the market economies truly became significant. Doehaerd, *The Early Middle Ages in the West*, pp. 149–216, explores the evidence for the movement of specific foodstuffs within the marketplaces. See Ronald E. Seavoy, *Famine in Peasant Societies* (New York, 1986), esp. pp. 1–124, for a highly negative examination of peasant subsistence agriculture and peasant motivations.

¹⁸⁶ Hodges, *Dark Age Economics*, p. 139.

¹⁸⁷ H. H. Lamb, *Climate: Present, Past and Future, 2: Climatic History and the Future* (London, 1977), pp. 426–29.

¹⁸⁸ *Annales Quedlinburgenses*, MGH SS 3:33; *Annales Weissemburgenses*, MGH SS 3:33; *Lamberti Hersfeldensis Annalium*, MGH SS 3:33; *Annales Petaviani*, MGH SS 1:7; *Annales Laureshamenses*, MGH SS 1:24; *Annales Alamannici*, MGH SS 1:24; *Annales Nazariani*, MGH SS 1:25; *Annales Einsidlenses*, MGH SS 3:138; and *Annales Sangallenses maiores*, MGH SS 1:73.

¹⁸⁹ Peter Garnsey, “Responses to Food Crisis in the Ancient Mediterranean World,” in *Hunger in History: Food Shortage, Poverty, and Deprivation*, ed. Lucile F. Newman (Oxford, 1990), pp. 126–46. For definitions of scarcity versus famine, see p. 126. Also see Seavoy, *Famine*, for comparative studies of peasant populations; and Jan de Vries, “Measuring the Impact of Climate on History: The Search for Appropriate Methodologies,” *Journal of Interdisciplinary History* 10 (1980), 602. The entire issue is devoted to climate and history, with a focus on the early modern and modern eras.

weather events could adversely affect nutrition. The chronicler links abnormally heavy precipitation to molds or rusts in the legume and grain crops. Perhaps the outbreak of human and animal disease also mentioned for that year was connected to consumption of contaminated plants.¹⁹⁰

Larger-scale difficulties affected the decade of the 860s, when shortages triggered by apparent droughts spread across much of temperate Europe. Problems began in 860 with an exceptionally hard winter. Trees and winter-sown crops were destroyed by the cold, and much livestock froze to death.¹⁹¹ Alamannia and Raetia experienced either famine or severe scarcity during 861, and in 862 the same fate befell Saxony, other German lands, and perhaps Europe in general.¹⁹² There seems no doubt that true famine affected Aquitaine, Burgundy, Germany, and perhaps most of the Continent in 868. Perhaps a poor fall harvest (not mentioned in the chronicles) in 867 triggered this famine, which peaked late in the following spring. At Sens 56 people were said to have died in one day, and some men and women resorted to cannibalism as a last-ditch effort to stave off starvation. In France, at least, the great famine was mercifully followed by rapid growth of the spring crop. By mid-June the first loaves of bread from the harvest were offered as gifts to God by a grateful (if haggard) population.¹⁹³

Yet another climate-related event affected the food supply of Germany and Francia during the years 873–74: locusts that came from the east and devastated the crops during the late summer months before the harvests.¹⁹⁴ The great numbers mentioned must have been the result of warm conditions in the lands east of Saxony that allowed insects to reproduce at an extremely high rate. In this instance, weather that benefited insect reproduction clearly had terrible consequences for humans.

Damages caused by weather and weather-related outbreaks of pestilence could affect both cultivated and foraged food supplies. Droughts that destroyed or

¹⁹⁰ *Annalista Saxo*, MGH SS 6:572; the chronicler notes, “Propter iuges pluvias et aerem nimio humore resolutum magna incommoda contigerunt. Nam et hominum et boum pestilentia grassata est; frumenta quoque et legumina corrupta sunt.”

¹⁹¹ The *Annalista Saxo*, p. 577, reports a “Hybernum tempus asperum nimis et solito prolixius erat, frugibusque et arborum proventibus pernoxium, nixque sanguinolenta in plerisque locis cecidisse reperta est”; also see, among others, *Annales Sangallenses maiores*, p. 76; *Annales Formosenses*, MGH SS 5:35.

¹⁹² *Annales Sangallenses maiores*, p. 76; *Annales Einsidlenses*, p. 140; the *Annalista Saxo*, p. 577, states that “Fames magna et morbus in Germania et in aliis Europae partibus fuit.”

¹⁹³ *Annales Sanctae Columbae Senonensis*, MGH SS 1:103: “Extitit eo anno fames et mortalitas inaudita per totam fere imperium Francorum, sed maxime per Aquitaniam et Burgundiam, ita ut prae multitudinem morientium non essent, qui sepelirent. Nam Senonis civitate inventi sunt uno die 56 homines mortui. Inventi sunt etiam ea tempestate in eodem pago masculi et femine pro nefas! homines alios occidisse et comedisse. Nam in Ponto Siriaco quidam onestam feminam ospitio susceptam occidit, membratimque dividens sale condivit, et sibi suisque filiis comedendam coxit. In ipsa urbe quedam femina de quodam adolescentulo similiter fecit. . . . Sed divina providente clementia novi fructus temperius solito succurrerunt. Nam 9. Kal. Iunii, primo videlicet die rogationum, panis novus oblatum est Senis ad benedicendum, ex quo plurimi gratias Deo referentes eulogias sumpserunt.” Also see *Annalista Saxo*, p. 580; *Annales Hildesheimenses*, MGH SS 3:47; and *Annales Sangallenses maiores*, p. 76.

¹⁹⁴ *Annalista Saxo*, p. 582: “Locustarum inaeestimabilis multitudo mense Augusto ab oriente veniens, totam pene pervastavit Galliam”; also reported for Germany in *Annales Hildesheimenses*, p. 48; *Annales Quedlinburgenses*, p. 48; and *Annales Weingartenses*, MGH SS 1:66.

stunted domestic grains and vegetables also prevented the growth of protein-rich wild mushrooms, which require moisture to thrive. Late spring freezes that prevented domesticated fruit trees from setting their fruit were likely to have the same effect on wild fruits and berries in the neighboring meadows and forests. If oaks and other trees failed to produce acorns and nuts, a community's pigs would put on less meat before the late fall slaughter. If acorns alone failed, pigs could feed off protein-rich nuts of other sorts—but humans would then have fewer nuts for their direct consumption.

Early-medieval warfare may have been as great a threat to the food of local communities as the weather. Military campaigns or raids reduced available food supplies both through foraging and the deliberate destruction of crops, livestock, and even peasants as a means of intimidating the opposing side. Charlemagne's campaigns in Saxony devastated the countryside in the hopes of subduing the population.¹⁹⁵ The Vikings burned and plundered when they attacked Frisia in 834 and 837, Rouen in 841, and they settled in to plunder Francia on a virtually yearly basis from the mid-850s. At least as devastating as the Vikings were the civil conflicts that began between Louis the Pious and his sons and continued by their descendants throughout the ninth century.¹⁹⁶ Agriculture was so disrupted in Gaul in 843 that the inhabitants were forced to eat bread made of earth and flour in order to survive, although the chronicler indignantly notes that the armies had plenty of food themselves.¹⁹⁷

The frequent destruction or theft of crops by domestic livestock, wild animals, and humans could seriously erode a household's food supply. Some form of redress was available under law for the ravages of thieves and domestic livestock. While no calculation of the levels of depredation is possible, the number of Germanic laws dealing with the problems of theft and destruction within fields and kitchen gardens makes it clear that this was a serious issue in all communities.¹⁹⁸ Thefts could be internal: *De villis* warned of the machinations of peasants who would hide seed in an attempt to reduce the amount of produce allocated to the king's court and household. Such a strategy might have enhanced the resources of an individual household, but it might also have hindered the accumulation of common stores accessible to all in times of shortages.¹⁹⁹

The Christian fasts, which restricted meat or alcohol consumption, further lim-

¹⁹⁵ Bernard Walter Scholz, ed., *Carolingian Chronicles: Royal Frankish Annals and Nithard's Histories* (Ann Arbor, Mich., 1970), for 784 and 795. Also see *Annalista Saxo*, pp. 560–63, for 782–93, with its matter-of-fact references to “vastando omnia” or “omnia incendiis.”

¹⁹⁶ *Annales Bertiniani*, MGH SS 1:428–38, 448–515. A useful translation is *The Annals of St. Bertin*, ed. Janet Nelson (New York, 1991). The *Chronicon Benedictoburanum*, MGH SS 9:218, describing the first onslaught of the Hungarians, notes that “odibiles et maligni homines Hungarii intraverunt provinciam cuncta vastantes, ecclesias et monasteria monachorum et virginum depraedaverunt ac postmodum incendio ignis cuncta consummaverunt.”

¹⁹⁷ *Annales Bertiniani*, p. 439: “Emergentibus igitur hinc inde tot tantisque incessabiliter malis, vastante passim cuncta raptore, coacti sunt per multa totius Galliae loca homines terrae mixtam paucitatem farinae atque in panis speciem redactam comedere, eratque lacrimabile imo execrabile nimium facinus, cum iumenta raptorum pabulis abundarent, et homines ipsius terrena admixtionis crustulis indigerent.”

¹⁹⁸ For examples, see *Pactus legis Salicae*, pp. 21–51, titles 2–9.

¹⁹⁹ *De villis*, p. 88, chap. 51.

ited access to high-quality protein among observant Christians. Fasting served “to force the body toward virtue”²⁰⁰ and curbed sexual desire through the metabolic changes set in motion by semi-starvation.²⁰¹ Fasting was frequently used as a form of penance for the contrite.²⁰² The Carolingians attempted to enforce the church’s teachings concerning fasting through secular legislation. While abstinence from meat undoubtedly made the good Christian ponder spiritual matters, it could also erode the health of those in society who were marginally nourished already. Elite women anxious to display their spirituality were most at risk, since low-protein intake could affect both them and any child they might be carrying.²⁰³ Fasting was even more of a problem because the great fasts concluded with great feasts—a form of binging after prolonged restrictions that equally disrupted the body unaccustomed to substantial quantities of meat, alcohol, or fats.²⁰⁴

The distribution of foodstuffs by age, gender, and social class could also affect nutrition. Benedict’s Rule specified that the young were to be allocated less food than adults, although he did permit them to eat at odd hours. The elderly and the ill were also accorded greater leniency in eating, especially the ailing, who were exempted from the restrictions on meat.²⁰⁵ Reduced rations for both nuns and women servants—and presumably all women within the community—were based on their smaller size and supposed lesser need for food. This continued a pattern seen in classical society.²⁰⁶ Teachings of the church fathers that emphasized women’s role as sexual temptresses may also have been a factor limiting their access to food, since fasting reduced sexual inclinations and was specifically used by the early-medieval church for this purpose.²⁰⁷ Among the foods distributed according to social class were cheese, eggs, and fish. The regular mention of cheese and eggs among the dues of tenants, as well as the amounts that are stipulated, seems to suggest that these foods served the peasants more as a form of cash than

²⁰⁰ Bynum, *Holy Feast*, p. 38.

²⁰¹ Peter Brown, *The Body and Society: Men, Women and Sexual Renunciation in Early Christianity* (New York, 1988), pp. 224–25.

²⁰² *Penitential of Theodore*, in McNeill and Gamer, *Medieval Handbooks*, pp. 184–215, esp. book 1, chaps. 1.6; 2.19–20; 4.4; 8.3, 4, and 9; 11.2–4; 12.8; 14.2–4, 9–10, 12, 16–18, 23–24; and book 2, chaps. 14.1–2, 14.

²⁰³ See n. 223, below.

²⁰⁴ Data on the effects of weight cycling are still mixed. Lauren Lissner, Patricia Odell, and Ralph B. D’Agostino, “Variability of Body Weight and Health Outcomes in the Framingham Population,” *New England Journal of Medicine* 324 (1991), 1839–44, and Peggy Hamm, Richard B. Shekelle, and Jeremiah Stamler, “Large Fluctuations in Body Weight during Young Adulthood and Twenty-Five Year Risk of Coronary Death in Men,” *American Journal of Epidemiology* 129 (1989), 312–18, conclude that males who experience weight fluctuation may have higher mortality rates. Susan Jebb, Gail Goldberg, and W. A. Coward, “Effects of Weight Cycling Caused by Intermittent Dieting on Metabolic Rate and Body Composition in Obese Women,” *International Journal of Obesity* 15 (1991), 367–74, found no additional risks for women.

²⁰⁵ *RB 1980*, pp. 234–41, chaps. 36, 37, 39–41.

²⁰⁶ Ann Hagen, *Handbook*, p. 68, discusses the lower rations allocated to female servants. Plutarch’s biographies reveal that Lysurgus was unusual in legislating that Spartan women citizens be as well fed as men; Solon was presumably more typical in restricting women’s access to food as one way of regulating their behavior. Sarah B. Pomeroy, *Goddesses, Whores, Wives and Slaves: Women in Classical Antiquity* (New York, 1975), pp. 202–3, discusses inequities in the imperial grain dole.

²⁰⁷ Brown, *Body and Society*, pp. 220–24; Bynum, *Holy Feast*, pp. 33–41.

as regular items of diet.²⁰⁸ As noted above, Charlemagne's fondness for a cheese served him by a bishop led him to request that his host deliver two cartloads annually to the palace at Aachen. The bishop's reluctance to comply revealed the difficulty of producing this type of cheese, and perhaps cheese in general, for Charlemagne relented after two years and allowed the bishop to escape this burden.²⁰⁹ The anecdote illuminates the value of cheese for the lay and clerical elite who depended on it as a source of nourishment when they abstained from meat. The same elites depended on fish as another mainstay of the meatless regime. The difficulties of obtaining a steady and abundant supply of fish in inland areas probably prompted their exclusion from the daily rations of monastic communities. In these circumstances, it would be surprising to find a fish in every peasant's pot on a regular basis. During fasts or in times of meat shortages, the lower classes had to rely upon a dreary and seemingly endless round of grains, legumes, and vegetables.²¹⁰

The majority of early-medieval people likely suffered some degree of malnutrition resulting from the irregular availability of foods necessary to a balanced diet. The best evidence of overall inadequacy can be seen in mortality statistics, which reveal that infant death rates were appallingly high, that women routinely lived shorter lives than men, and that overall average life expectancy for either sex rarely exceeded 35–40 years. The peoples of early Anglo-Saxon Britain seem to have lived an average of 30 years, with women experiencing a shorter average life expectancy than men.²¹¹ The Carolingian family, despite access to the best foods available, had average life spans of 36 years for women and 39–40 years for men.²¹² Figures for seventh-century communities near Stuttgart reveal early average ages of death among all social classes: at Schretzheim and Sontheim, women reached average ages of 22 and 24 years, while males averaged 44 and 42 years respectively. At other communities, life expectancy was better balanced: at Hemmingen men averaged 37, women 33 years, while Weingarten males averaged 42 years, women 35.²¹³ Bavarian remains reveal mortality rates as high as 45 percent among those under 20 years of age, with the first 6 years of life being particularly hazardous.²¹⁴ The percentage of the population surviving into their sixties was rarely better than 7 percent.²¹⁵ While warfare and childbirth undoubtedly accounted for much of

²⁰⁸ For examples see *Polyptyque de Saint-Remi*, pp. 14, nos. 2 and 4; 24, nos. 1 and 2; 41, no. 10; and *Polyptyque de Saint-Germain-des Prés*, pp. 254, no. 41; 263, no. 21; 269, no. 47; and 360, no. 34.

²⁰⁹ *De gestis Karoli Imperatoris*, MGH SS 2:737.

²¹⁰ See Bynum, *Holy Feast*, p. 41.

²¹¹ C. J. Arnold, *Roman Britain to Anglo-Saxon England* (Bloomington, Ind., 1984), pp. 124–26.

²¹² Suzanne Fonay Wemple, *Women in Frankish Society: Marriage and the Cloister, 500–900* (Philadelphia, 1981), pp. 199–201.

²¹³ Alfred Czarnetzki, Christian Uhlig, and Rotraut Wolf, *Menschen des frühen Mittelalters im Spiegel der Anthropologie und Medizin*, 2nd ed. (Tübingen, 1985), pp. 10–12, 27.

²¹⁴ Gerfried Ziegelmayer, "Die Bajuwaren aus anthropologischer Sicht," in *Die Bajuwaren*, pp. 253–57.

²¹⁵ Ziegelmayer, "Die Bajuwaren," p. 254.

the early mortality, nutritionally related diseases such as scurvy, beriberi, and anemia also played a significant role.

Specific health problems are documented or suggested by some surviving skeletal remains. All populations certainly suffered from tooth loss, both a cause of poor nutrition and the result of it. Early-medieval peoples consumed much less simple sugar than today's population and were therefore much less susceptible to dental caries.²¹⁶ However, their inadequate dental hygiene allowed plaque to build up above and below the gum line, causing periodontal disease, abscesses, tooth loss, and eventual bone decomposition. Scurvy, and its resultant tooth loss, was endemic in the winters.²¹⁷ Missing teeth impaired the ability to chew and thus to digest food properly, with the result that some people may have died of malnutrition even when there was abundant food.²¹⁸

A lack of knowledge concerning children's special nutritional needs certainly accounted for a substantial number of deaths from "failure to thrive" syndrome. Infants and young children actually require a disproportionate amount of nutrients for their body weight.²¹⁹ The very young were especially at risk because of their dependency on mother's milk. If a mother died during birth, or could not nurse owing to a lack of milk brought on by nutritional inadequacies, the infant's only hope was a wetnurse.²²⁰ Inadequate nutrition also weakened the not fully developed immune systems of children, creating a form of double jeopardy that left them as a community's most susceptible victims of any potential ailment or epidemic.²²¹

Female mortality has been well examined by Vern Bullough and Cameron Campbell. They rightly attributed the low average age at death of many early-medieval women to the iron drain and consequent anemia triggered by the repetitive cycle of pregnancy, childbearing, nursing, and lack of birth spacing.²²² Iron deficiencies were probably common among women within celibate communities who failed to replace iron lost through the menstrual cycle with an adequate

²¹⁶ Czarnetzki, *Menschen*, pp. 14–15.

²¹⁷ Dominick P. DePaola, Mary P. Faine, and Richard I. Vogel, "Nutrition in Relation to Dental Medicine," in *Modern Nutrition*, pp. 1007–28. Also see Tony Waldron, "The Effects of Urbanisation on Human Health: The Evidence from Skeletal Remains," in *Diet and Crafts in Towns*, p. 57.

²¹⁸ Czarnetzki, *Menschen*, pp. 83–90, documents the state of dental trauma among several communities.

²¹⁹ *Modern Nutrition*, appendix, tables A-2b, "Recommended Daily Dietary Allowances"; A-2c, "Estimated Safe and Adequate Daily Dietary Intakes of Additional Selected Vitamins and Minerals." "Failure to thrive" syndrome encompasses a range of nutritional deficiencies; it typically appears in poverty-stricken, malnourished populations. Ironically, it has recently become a problem in affluent households where well-meaning parents place young children on the same low-fat, low-salt, limited-meat diets recommended for adult coronary patients. See Michael Pugliese et al., "Fear of Obesity: A Cause of Short Stature and Delayed Puberty," *New England Journal of Medicine* 309 (1983), 513–18.

²²⁰ Neonates and young children tend to be underrepresented in many cemeteries because their shallow burials made them easily dug up by predators. Infants' and young children's graves often contain only portions of the skull or perhaps a limb or two.

²²¹ William C. Heird, "Nutritional Requirements during Infancy and Childhood," in *Modern Nutrition*, pp. 740–58, examines the dietary distinctions in detail.

²²² See n. 2, above.

supply of red meats. There were other potentially fatal nutritional problems facing women. Pregnancy, childbirth, and lactation created greater needs for calories, protein, A, D, thiamin, riboflavin, niacin, folic acid, B12, C, and calcium. These requirements were higher than those for their male contemporaries.²²³ Peasant women living on a subsistence diet of grains, legumes, and vegetables, high in fiber, lacked adequate protein, calcium, B12, C, and folic acid. The fiber may have impaired the absorption of calcium, magnesium, and zinc, and possibly other micronutrients as well.²²⁴ Calcium closely followed iron as the most important mineral deficiency, for it was necessary not only for bone renewal among adult women but for adequate bone development in their nursing infants.²²⁵ Ironically, dietary calcium may have been most available to those who needed it the least: the cheese-consuming celibate men and women of religious communities. B12 deficiencies produced anemias that threatened the lives of both mother and fetus.²²⁶ Another serious health hazard for women was posed by deficiencies of vitamin C and folic acid caused by the loss of fresh vegetables and fruits during droughts or floods. Both nutrients were available in a much more limited range of plants than we have today. Modern guidelines recommend that all pregnant women receive folic acid supplements in order to ensure proper fetal growth and to prevent birth defects such as spina bifida. Both the open form (where only skin covers the spine) and the closed form of this neural tube defect appear in early-medieval populations. Those born with the more severe form of spina bifida would typically have died in infancy from infections resulting from the lack of sanitary measures to protect the exposed tissues along the spine.²²⁷ Women experiencing the first trimester of their pregnancies during the winter and early spring—when fresh vegetables and fruits were least available—would have been most at risk for producing infants with this birth defect.

Rickets, the result of inadequate vitamin D in children, created skeletal deformities in its victims. Children born during the winter months and underexposed to the necessary sunlight were at considerable risk.²²⁸ The richest nutritional sources of D were saltwater fish, eels, veal, mushrooms, and offal, foods unlikely to be consumed regularly or readily by infants and children.²²⁹

Osteoporosis weakened the bones of older women and some men in their fifties and sixties who failed to take in enough calcium.²³⁰ Lack of exercise was not the

²²³ William J. McGanity, Earl B. Dawson, and Ann Fogelman, "Nutrition in Pregnancy and Lactation," in *Modern Nutrition*, pp. 705–27.

²²⁴ Schneeman and Tietyan, "Dietary Fiber," p. 97.

²²⁵ McGanity, "Nutrition in Pregnancy," pp. 742–44.

²²⁶ Herbert, "Folic Acid and Vitamin B-12," pp. 413–16.

²²⁷ Czarnetzki, *Menschen*, p. 66, presents a case in which the spinal cord was fully exposed through a 1-centimeter-wide canal in the bone. Walter Sage, *Das Reihengräberfeld von Altenerding in Oberbayern*, series A, vol. 14 of *Germanische Denkmäler der Völkerwanderungszeit* (Berlin, 1984), reports its occurrence in Bavarian populations; see graves 1137 and 1145.

²²⁸ Czarnetzki, *Menschen*, pp. 67–68, 78–79; and Waldron, "The Effects of Urbanisation," pp. 57–58.

²²⁹ *Nährwerte*, pp. 41–42.

²³⁰ Elizabeth A. Krall and Bess Dawson-Hughes, "Osteoporosis," in *Modern Nutrition*, pp. 1561–66; Sage, *Altenerding*, graves 117, 121, 123, 140, 227, 1145.

cause of osteoporosis as it can be in today's more sedentary population. Skeletons of men and women alike reveal that load-bearing exercise levels were excessive and caused long-term damage to the spine and joints.²³¹ Osteoporosis was occasionally complicated by other nutrient deficiencies, as in the case of one man whose bones bear witness to hemorrhaging caused by a vitamin K deficiency and to osteoporosis.²³²

The food supply may have been natural, but it certainly was not pure. Contaminants included insects, rodents, fecal matter of various sorts, poisonous weeds harvested along with the crops, dangerous herbs, molds, and viral or bacterial diseases resident in the animal populations. Some of the malignant tumors commonly found among the skeletal remains could be the result of frequent consumption of grains contaminated with carcinogenic molds such as the aflatoxins and *Fusaria*. Diet plays, and played, a significant role in a number of common cancers.²³³ Other natural toxins in the food may have triggered outbreaks of poisoning that appeared to be plague or the retribution of God. Hemlock could be lethal to both livestock and humans, while pennyroyal caused liver damage and miscarriages when consumed in relatively modest amounts.²³⁴ Both herbs were among those to be planted in the royal gardens.²³⁵ Tuberculosis passed from cattle to people through the consumption of unpasteurized milk infected with *Mycrobacterium bovis*. This particular form of tuberculosis, shared by cattle and humans, first appeared in Neolithic skeletons. The strain exclusive to humans first appeared around A.D. 1000. Populations suffering from malnutrition were especially susceptible. Tuberculosis could be fatal for infants consuming contaminated milk.²³⁶ The inflammation and general long-term systematic weakening induced by tuberculosis contributed substantially to average low life expectancy of European peoples who lived in a climate where *Mycrobacterium bovis* was endemic.²³⁷

Some ailments may have been the result of excessive consumption of certain foods rather than a lack of them. Members of the lay elite who ate excessive amounts of salted meat, cheeses, and fats and who drank excessive amounts of wine probably suffered from some of the diseases common to contemporary Americans who consume a high-saturated fat, high-sodium diet: obesity, high blood pressure, and cardiac diseases.²³⁸ Gallstones, linked to high cholesterol levels,

²³¹ Czarnetzki, *Menschen*, pp. 12–14, 31–34.

²³² Czarnetzki, *Menschen*, p. 77.

²³³ John N. Hathcock and Jeanne I. Rader, "Food Additives, Contaminants, and Natural Toxins," in *Modern Nutrition*, pp. 1602–4; Michael W. Pariza, "Diet, Cancer, and Food Safety," in *Modern Nutrition*, pp. 1545–58; Czarnetzki, *Menschen*, pp. 75–77.

²³⁴ Claire Kowalchik and William H. Hylton, *Rodale's Encyclopedia of Herbs* (Emmaus, Pa., 1987), pp. 152 and 154.

²³⁵ *De villis*, chap. 70.

²³⁶ James B. Wyngaarden and Lloyd H. Smith, Jr., eds., *Cecil's Textbook of Medicine*, 17th ed. (Philadelphia, 1985), pp. 1621–23; and Waldron, "The Effects of Urbanisation," p. 61.

²³⁷ Czarnetzki, *Menschen*, pp. 63, 81–82.

²³⁸ Sonja S. Connor and William E. Connor, *The New American Diet* (New York, 1986), pp. 17–30; *Diet and Health*, pp. 529–92; Elaine Feldman, "Nutrition and Diet in the Management of Hyperlipidemia and Atherosclerosis," in *Modern Nutrition*, pp. 1302–4; and Theodore A. Kotchen and Jane Morley Kotchen, "Nutrition, Diet and Hypertension," in *Modern Nutrition*, pp. 1287–97.

have been found in some individuals.²³⁹ Diabetics and those predisposed to develop the disease may have suffered from an ultimately fatal inability to metabolize a high-carbohydrate, high-fiber diet.²⁴⁰ The peasants and religious living on a routine diet of legumes, whole-grain breads, and vegetables were the best potential candidates for developing this metabolic disorder.

Did the early-medieval diet offer the potential for sound nutrition? Abundance was theoretically possible, and is suggested by the evidence of monastic rations calling for enormous daily calorie intake. But against this conclusion are the realities reflected in other sources, which document the measures taken to protect a community's food; in the appalling accounts of natural disasters; in the matter-of-fact mention of shortages even on the better estates; and in the evidence offered by the remains of early-medieval populations. On the whole, it seems that the evidence favors a negative conclusion. The minutely detailed inventories reflect this world in which literally every egg counted as a precious part of the most basic element of human existence after birth: the maintenance of life through eating and drinking.

²³⁹ Sage, *Altenerding*, graves 187 and 921; F. Xavier Pi-Sunyer, "Obesity," in *Modern Nutrition*, pp. 991–92.

²⁴⁰ Czarnetzki, *Menschen*, p. 65; and A. Garg et al., "Effects of Varying Carbohydrate Content of Diet in Patients with Non-Insulin Dependent Diabetes Mellitus," *Journal of the American Medical Association* 271 (1994), 1421–28. Garg's study is at the heart of current controversy surrounding diabetes, the predisposition to develop diabetes, and the therapeutic use of low-fat, high-carbohydrate diets.