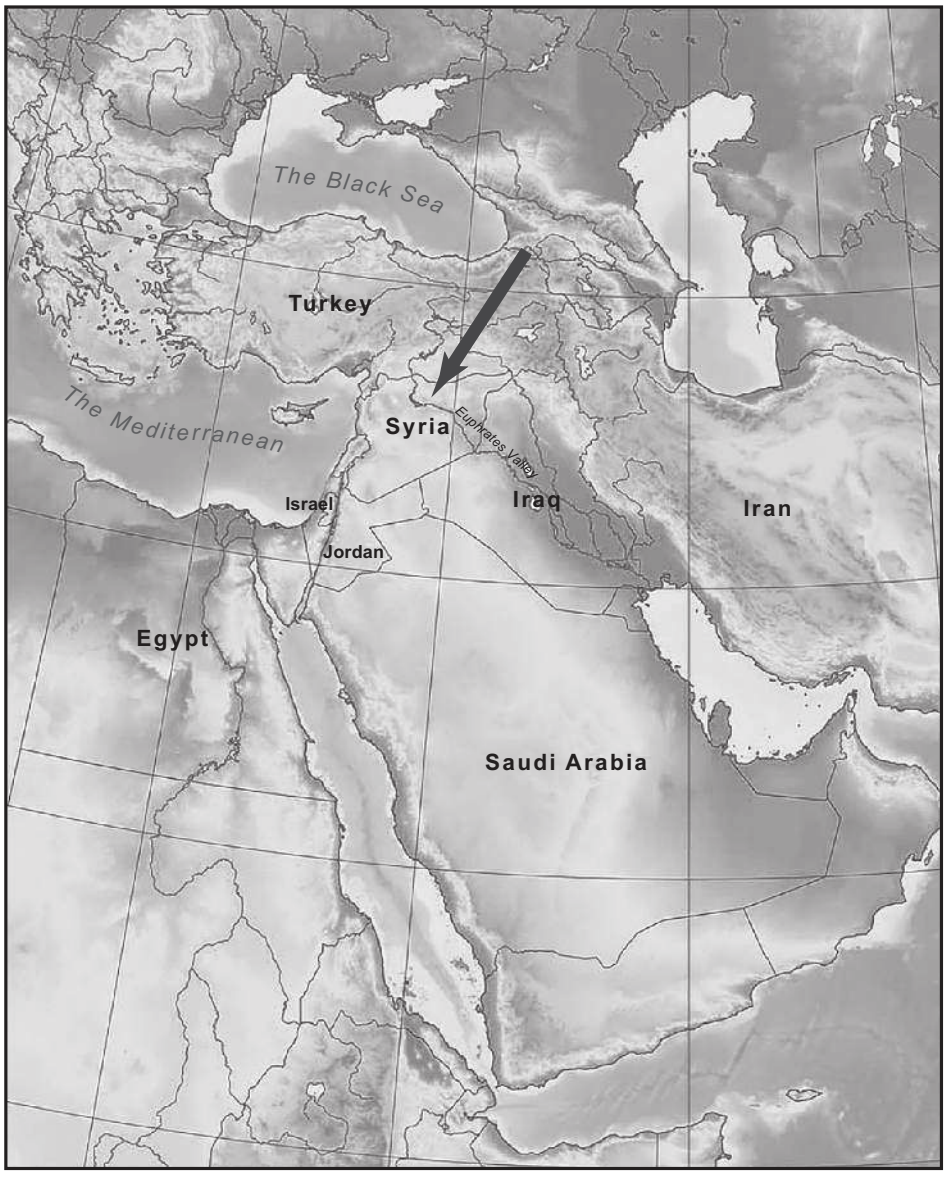
INTRODUCTION

This book is about plant domestication and the origins of agriculture in the Near East (Figure Introduction 1), which were major components of the process known as the Agricultural Revolution or the Neolithic Revolution.[1] The expansive discussion we offer in this book is restricted to plant domestication; animal domestication, a broad subject in its own right, is treated in a contribution by Professor Gila Kahila Bar-Gal (see Chapter 14). The term 'domestication' (or 'plant domestication') in the context of the current work carries both biological and cultural significance. From the biological perspective, it implies the acquisition of new traits that differ from the prevalent wild type plant while the cultural perspective denotes a change in worldviews and life-ways enabling the adoption of plants for food production. Throughout this book we distinguish between the Agricultural Revolution (see Glossary, General Terms, Agricultural Revolution) as a general socio-cultural transformation and the domestication (see Glossary, General Terms, Plant domestication) of plants (and animals) as a single aspect of this multifaceted human development.

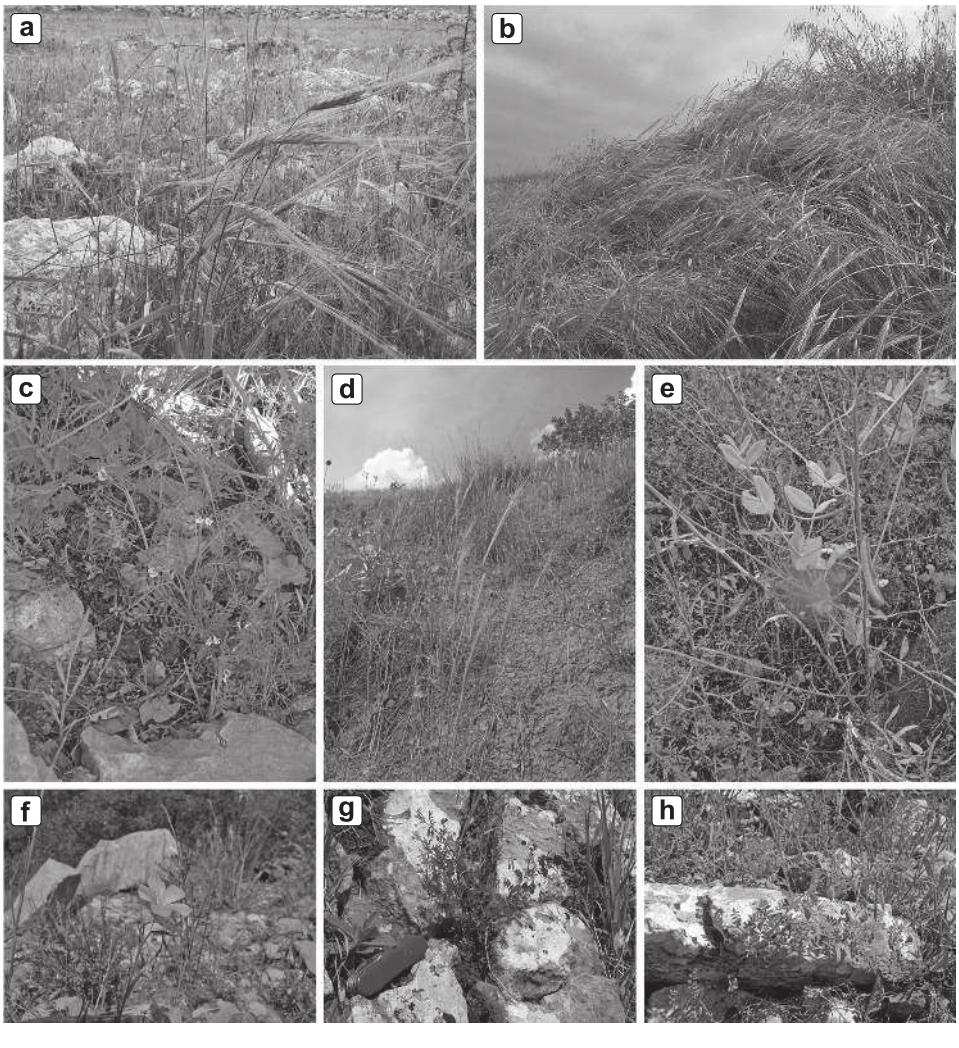
This book, then, aims mainly at addressing key questions concerning plant domestication in the Near East (some 10,500 years ago) while exploring the new and particular relationship that ensued between humans and plants as well as the general interaction that developed between human/culture and nature. We offer a discussion on some of the fundamental questions that relate to the broader cultural transformation (the Agricultural Revolution), including: What is the Agricultural Revolution? When and where did it occur? How did it occur? And, perhaps most important, why did it occur?



Int. 1
General map of the Near East; the core area we suggest as the home of plant domestication is denoted by an arrow.

Some of the answers may be simple and fairly straightforward, but others are difficult and complex, pertaining to the very foundations of our human existence.

Plant domestication in the Near East occurred some 10,500 years ago, during the Neolithic period (the New Stone Age). The Near Eastern *founder crops*, that is, the group of plants that were to be domesticated and become the Neolithic plant package, were



Int. 2
Wild progenitors of the Near Eastern domesticated plant package: (a) emmer or durum wheat, (b) barley, (c) bitter vetch, (d) einkorn wheat, (e) pea, (f) flax or linseed, (g) lentil, (h) chickpea (refer to Table 4.1 for Latin names and progenitors). Colour versions of these images can be found at www.cambridge.org/abbo-gopher.

barley, two wheat species, pea, lentil, chickpea, bitter vetch and flax (Figure Introduction 2). These crops are still in use, providing a significant part of the agricultural produce used to feed both humans and livestock. Considering the animals that were domesticated at the same time – goats, sheep, cattle and pigs – it is easy to see that some of the prominent food products consumed worldwide to this very day were, in fact, singled out 10,500 years ago and adopted as part of the Agricultural Revolution. The transition to an agricultural way of life necessitated far-reaching changes in

humankind's perceptions, worldviews, social structure and institutions, all of which led humanity to its familiar, modern state.

It is important to remember that agricultural revolutions also occurred independently in other world regions, where other crop plants were adopted, including cereals (e.g., rice, maize), legumes (e.g., soy bean, common bean) and species from other plant families (Solanaceae, Cucurbitaceae, Compositae, Malvaceae), according to the wild species repertoire of each region (e.g., potato, pumpkin, sunflower, cotton respectively). We are in awe of the creativity and vision of Neolithic societies and their striking capability worldwide to find useful plant and animal species suitable for domestication as well as their adeptness in applying the delicate and sophisticated decision making that was required for domestication. Despite typical challenges in the early days of agriculture, this was a highly successful system,[2] as attested by its global sweep, and to date it underlies the socio-economic organization of most human societies.[3] In fact, it is rather difficult to find an inhabited region anywhere in the world today that is devoid of agriculture.

This is neither a botany nor archaeology textbook.[4] It is rather a volume aimed at a wider intellectual readership of knowledge-seekers. To facilitate reading, we hope the text below describing how the book is structured, and the logic threaded in and between its chapters, will assist readers in following our arguments and suggestions regarding plant domestication in the Near East. Certain chapters are also laced with explanatory boxes and illustrations that clarify terms and introduce the archaeological sites or data upon which we base our claims. A Glossary with short definitions and explanations of professional terms appears at the end of the volume.

Any discussion of plant domestication is multifaceted and complex. In the Near East, this discussion is characterized by a series of bipolar, dichotomous questions regarding the *where*, *when* (and at what pace) and *how* of plant domestication.

The first question to ask, then, as it governs answers to all other questions, is whether or not there was a core area (within the Near East) in which plants were first domesticated and from which they spread, and if such an area did exist, where it was located. We respond positively to the first question, and determine, based on available data, that this area was located in south-eastern Turkey and northern Syria. Accordingly, we maintain:

- that founder crops were domesticated in a single episode;
- that this single episode was led by a specific set of considerations (e.g., cultural, economic, agronomic, nutritional);
- and that these considerations, in turn, affected other aspects of the process, such as pace (was it rapid or slow?); or consciousness (were the actions of the domesticators deliberate?); or knowledge (was the process knowledge-based and pre-planned, or was it an accidental by-product of human behaviour?).

We now map out for the reader the plan and scope of the book. The brief overview of each chapter stresses our main insights regarding the different aspects of

plant domestication, and provides the basic knowledge required to understand and support our claims.

In Chapter 1, we review the background and the time frame of plant domestication and the Agricultural Revolution in the Near East. We show the place of the Agricultural Revolution on a long continuum of revolutions (or transformations) from ancient to modern times, including 'man the tool-maker', the emergence of agriculture, the rise of city-states or urban centres, the Industrial Revolution and the Digital (computerized, virtual, information/communication technology) Revolution that is still unfolding around us. We introduce plant domestication in the broad context of domestications that build a picture of cultural change, through which humans from the very earliest times came to appropriate, dominate and regulate the world's natural resources – a time, for example, when they came to control stone and fire, domesticate plants and animals (the Agricultural Revolution), manage water (dig wells and irrigate farm land with canals), manipulate clay (vessel making) and metal (copper and iron making) and possibly even domesticate and discipline themselves and their own species. Since the domesticators of plants (and animals) were hunter-gatherers living in small communities, we devote a short discussion to the characteristics of these societies while also comparing them to the subsequent food-producing societies. The dwelling sites of these two types of societies, their mobility patterns across the landscape, the economic and demographic aspects of the two systems, the social structure and organization of their respective lifestyles, and the differences in worldviews between them are briefly presented, especially as they pertain to the human–world or culture–nature relationships. In essence, in this chapter we sketch, in general, the socio-economic consequences of the Agricultural Revolution and seek to establish how this socio-cultural transformation led to the modern human condition and the birth of our current civilizations.

Chapter 2 is devoted to the archaeology of the Fertile Crescent, especially its western wing, towards the end of the last Ice Age (Pleistocene) and the early Holocene, the present age.[5] We offer a short historical review pertaining to human dwelling sites, technology and tools (mainly flint and stone) and life-ways during the long period known as the Epipaleolithic (ca. 23,000–12,000 years before present, or cal BP).[6] We then introduce the Neolithic period (ca. 11,800/700–6,500 cal BP), during which Near Eastern plant domestication occurred and farming economies were established. Some relevant archaeological sites and findings are described in text boxes and illustrations. We offer only a brief and broad overview in the hope of stimulating our readers to seek further knowledge of these topics. Through archaeological findings, we delineate the transformation in the archaeological landscape before and after the Agricultural Revolution. The establishment of farming communities was accompanied by massive changes in human culture and worldviews, marking the end of some three million years of Paleolithic human existence and perceptions. The new world, the Neolithic world, was distinguished by its large sedentary populations dwelling in permanent sites, a new economy that was based on food production, and a new, more complex and less

egalitarian (ranked and later stratified) social organization, to name but a few of the characteristics of this new era.

In Chapter 3, we review the different explanations offered over the years for the questions we raised earlier: When did the Agricultural Revolution occur? Where? How? And why? Additional features of hunter-gatherer societies are discussed as background to some of the explanations and models of the Agricultural Revolution. The explanations presented here are divided into two categories: (1) the models that view the Agricultural Revolution as a consequence of external (e.g., environmental) influences and stress factors (resource depletion) that led to the adoption of new subsistence resources; (2) explanations that consider changing perceptions, worldviews and the socio-economic order as the transformational drive of social restructuring and new life-ways. The first set of explanations emphasize the reactive nature of humans and their culture when facing external forces. The second group of explanations – the one to which we subscribe – consider human agency and human initiative as the major drivers of social and cultural changes that were but one possible choice of action and not necessarily one related to stress. In our view, the Agricultural Revolution and plant domestication were the result of human social dynamics that emerged due to perceptual and ideological changes. Reviewing both types of models emphasizes their respective underlying viewpoints, thereby helping to elucidate our own stance that plant domestication was a proactive, knowledge-based skilful development.

In Chapter 4, we describe the environment in which the Agricultural Revolution and plant domestication took place. We discuss the natural arena of these events, including climate, physical landscape and the ecology of the Near East. The founder crop species and their wild progenitors are presented as necessary background for understanding the bio-mechanisms of domestication.[7] The geology and climate regime (mostly precipitation seasonality) of the eastern Mediterranean Basin create a rich and highly diverse but also highly vulnerable environment, the richness of which is not always easily detected. The potential of floral diversity, including the wild progenitors of the founder crops (as well as the animals to be domesticated), was in this case a hidden treasure awaiting use by local 'owners', to draw on Ecclesiastes (Chapter 5:13, KJB). Such areas, rich in the species of plants (and animals) that were later domesticated, coupled with suitable conditions for such a move, are rare in the world, as noted by Jared Diamond in his book, *Guns, Germs, and Steel* (1997).

In Chapter 5, we describe the main differences between wild and domesticated plants, we explore the traits that allow wild plants to adapt to their habitat and show how these traits are relevant to domesticated plants. Some of these traits, known collectively as the *domestication syndrome*, are described with respect to the Near Eastern founder crops, including seed dispersal, seed dormancy, pest and disease resiliency, adaptation to climatic rhythm (seasonality), the extent of genetic diversity, nutritional value and the economic value of various plant parts, among others. We conclude that although general similarity renders most domesticated plants 'alike' (e.g., most Near

Eastern annual crops are self-pollinating), researchers are not exempt from studying the unique peculiarities of each of the founder crops that required specific attention by the ancient domesticators.

In Chapter 6, we probe the differences between modern and traditional (subsistence) agricultural systems, preparing the reader to understand the economic, nutritional and agronomic considerations underlying the adoption of species that finally made the Neolithic crop package. We present the differences between low-input traditional systems targeted at subsistence farming and modern systems that necessitate expansive infrastructures targeted at large-scale commercial industrial production.

In Chapter 7, we explore a highly controversial issue in current plant domestication research: plant domestication (adoption of a wild plant for cultivation) versus crop evolution under domestication (all post-domestication improvements and changes, including modern breeding). Our main contention is that domestication occurred in a short, rapid episode, often requiring just a single (crucial) genetic change in the wild type to enable profitable cultivation. Accordingly, many of the other traits that differ between wild and domesticated plants evolved over millennia under domestication in farmers' fields and were not necessarily associated with the pristine domestication episode. The domestication syndrome is discussed with respect to three species of the founders' crop package – chickpea, pea and emmer wheat – emphasizing the distinction between adaptations that occurred as part of the domestication episode and subsequent evolutionary changes that took place under domestication. We thus attempt to single out those traits that were crucial for domestication vis-à-vis those that did not interfere with usage or cultivation. We believe that this distinction is critical for understanding domestication and our ability to determine whether it was a long, protracted process or a rapid, short event. Literature advocating the former is deficient in its discussion of this issue and therefore bases its argument on plant adaptations that are unrelated to domestication and which continue to evolve as part of the evolutionary trajectory of domesticated plants (such as in modern plant breeding).

Chapter 8 is dedicated to the distinction between cereals and legumes – the two prominent plant groups within the Near Eastern domesticated plant package. Cereal and legume crops are the backbone of agro-eco-systems in several world regions. The biological features of these two crop groups suggest that their mode of domestication was entirely different, determined by plant stature, growth habit, reproductive biology, seed dormancy and other traits. We also present traits of plants that belong to neither group, such as flax and a domesticated plant whose wild progenitor is unknown – the broad (faba) bean. We conclude that domesticating cereals and legumes required different approaches and skills, and that legume domestication probably required more ingenuity and sophistication on the part of the early farmers. This is because wild and domesticated cereals share similar traits and growth habits, with both growing rather densely. In contrast, the sparse patches in which the progenitors of the domesticated legumes grow in the wild are quite different compared to their appearance in full

canopy cultivated fields, thus necessitating a different approach (a conceptual leap) from the one that would be applied in the domestication of cereals. Another important conclusion regarding this crop combination is that it improves yield stability of the farming system in addition to providing balanced amino acid (whole protein) nutrition. We believe that this was likely the driver of similar domestication patterns in other world regions as well. A third conclusion emerging from these facts seems to have eroded in our busy modern world: that the main goal of subsistence farming systems is not yield maximization but rather the maintenance of stability of crops and produce, thereby contributing to sustainability.

In Chapter 9, we discuss the choice of the Near Eastern wild candidates for domestication with respect to availability, nutritional value of each individual species, agronomic potential both in isolation and as components of the whole crop package, and their contribution to overall agronomic balance and yield stability. The natural productivity of the individual wild species, that is, their caloric and nutritional value, does not always provide a satisfactory explanation for their adoption, namely, it is not always a good predictor of the agronomic potential and often does not reflect the likely incentive for adoption in antiquity. We therefore turn to other traits, such as the unique nutritional contribution of each species, their taste, agricultural compensation potential and ease of manipulation. The three crop cases we discuss as examples – chickpea, lentil and pea – provide support for the notion of knowledge-based, fully conscious plant domestication in the Near East.

In Chapter 10, we return to our central questions: When, where and how did plant domestication occur? We offer our model, by which domestication was a short-lived episode, occurring in a limited area, ca. 300 km in diameter, some 10,500 years ago. We show in many diverse ways that domestication was premeditated (conscious) and knowledge-based, and that it involved the full, harmonic plant package rather than each crop individually. We bring ample evidence from a broad range of disciplines to support our model, including archaeology, archaeobotany (the study of archaeological botanical findings), geobotany and genetics.

In Chapter 11, we divert from the discussion of grain crops to discussing fruit tree domestication, which sheds additional light on the deliberations involved in producing the Near Eastern domesticated plant package. We focus on the emblematic Near Eastern fruit trees – olive, fig, grape, date, pomegranate – which were the first to be domesticated in this region and which form five of the seven biblical species of food plants (fruits and grains) grown in the Land of Israel (and with the remaining two – barley and wheat – make up a food package in their own right). We compare the domestication of annual grain crops (cereals and legumes) to the adoption of perennial woody species as crop plants, thus depicting a broader general picture of plant domestication. These fruit trees were probably assimilated into farming systems several millennia after the domestication of annual crops, as this necessitated greater experience stemming from fundamental biological differences between annual and perennial growth, the long *juvenile*

period (see Glossary, Botany, Ecology and Agronomy, Juvenile period) and the understanding that the tree may change in appearance after its early years, in its reproductive biology (i.e., the flowering and fruiting patterns), and clonal (vegetative) propagation (see Glossary, Botany, Ecology and Agronomy, Clonal propagation). Additionally, tree growing involves a higher degree of delayed return, that is, it might take several years before trees yield produce and generate actual gain. Tree growing also involves a higher degree of long-term planning due to farmland allocation considerations and the prolonged lifetime of trees (e.g., several hundred years in the case of the olive).

In Chapter 12, we present post-domestication processes, namely, evolutionary processes that characterize domesticated plants in their domesticated habitat. We address the naturally occurring genetic variability of crop plants and explain the evolutionary forces that promote variability as well as those that restrict genetic variation, such as selective sweeps like the domestication bottlenecks. An immediate – although not innovative – conclusion arising from this discussion is that safeguarding genetic variability of crops (and wild plants) is fundamental for modern plant breeding, especially in light of the ever-increasing demand for the supply of high-quality foods in a globalizing world.

In Chapter 13, we extend our view to other world regions (domestication centres in America, Africa, Asia) and their respective crops. This review attests to independent, primary domestication centres of both annual crops and trees. Surveying the works of veteran bio-geographers such as de Candolle or pioneering geneticists like Vavilov raises questions concerning the ecological (dis)similarity of all domestication sites or the cultural independence (or lack thereof) of domestication centres. We discuss contemporary genetic variability and its significance to the sustainability of modern farming systems.

Animal domestication was part and parcel of the Near Eastern Agricultural Revolution and it is described separately in Chapter 14 by Professor Gila Kahila Bar-Gal, which unlike all other chapters includes a full academic apparatus (citations and a References section on p. 247). To make it reader-friendly, brief explanations of some of the terms and references to the Glossary are included. This chapter completes the picture of domestications in the Near East and provides a brief discussion and summary of the features of animal domestication that can be examined vis-à-vis plant domestication. Sheep, goats, cattle and pigs – the package of Near Eastern domesticated animals, or the 'Big Four' – were all domesticated within (or in the close vicinity of) the proposed core area of plant domestication in south-eastern Turkey and northern Syria. The wild progenitors and their ecological affinities are introduced and the differences between the wild forms and the domesticated livestock are highlighted. The archaeozoological record shows that domesticated morphologies appear rather abruptly and within a similar time frame to plant domestication. It is stressed that the differential feeding habits of the four livestock species grant flexibility to the farmer since there is little competition between them for food resources. As with plants, this chapter tends to suggest a knowledge-based choice of the four animals for domestication. Discussing the

possible incentives for animal domestication Professor Bar-Gal rejects climatic deterioration or resource depletion. She rather proposes that the motivation for animal domestication ought to be looked for in the cultural arena.

In Chapter 15, our final chapter, we summarize our views on the central questions of this work: When, where and how did plant domestication occur? We discuss the time frame of domestication, the domestication of fruit trees and genetic variability. We briefly touch upon the geographic spread of Near Eastern domesticated crops in ancient Europe and Asia and the consolidation of the founder crops (annuals and perennials) into a coherent agro-economic system. We look into cultural (historical and perceptual) aspects of domestication and humbly attempt to answer the question that remains open: Why domesticate? Was an economic need, driven by external factors, the major motivating force? Or was it a change in perception and ideology that initiated and led this irreversible cultural transformation? Undoubtedly, plant (and animal) domestication involved a transformational conceptual and socio-cultural restructuring of human society, and this ultimately led to the formation of complex, stratified, urban and modern societies. Plant and animal domestication and the institutionalization of agriculture have had a far-reaching influence on humanity, and they continue to influence our lives today. First and foremost, they have reshaped the human–environment relationship; they have driven many technological innovations; brought about the emergence of new industries and professional specializations; generated social reorganization from time to time and the construction of social institutions including labour division, gender relations and social ranking; and they might even have propelled the advent of gods and religions. These are all elements that have led humanity to its modern reality; they are still prevalent in our contemporary societies, and they are likely to continue and influence humanity in the near future.