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To the smallholder cocoa farming families who struggle with minimal reward in the hot and humid tropics to produce the raw material for chocolate, and to all who have worked to improve the life of cocoa farmers.

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PREFACE

Cocoa, the source of the raw material for making one of the world's great luxury foods, chocolate, evolved as an understory tree in the shade of Amazonian rainforests. It was first cultivated by the Mayan people and their forebears in Central America and is now produced mainly by about 6 million smallholder farmers in the equatorial tropics of West Africa, Southeast Asia and the Pacific region, and Central and South America. It has been a valuable pioneer crop, initially easy to grow and able to exploit the natural soil fertility accumulated under tropical rainforests. It is easy to process on farms to a durable product (dry cocoa beans) for transport and storage and has supported rural development in most places to which it has been introduced. But it proved especially prone to fungus diseases when it was cultivated in the Amazonian Basin and Central America, and to new-encounter pests and pathogens in all the other tropical countries to which it was introduced during European colonial expansion. These pest and disease problems and the debilitation of trees as the natural fertility of primary rainforest soils has become exhausted, have seriously compromised the livelihoods of farmers, and the sustainability of cocoa production and the cocoa processing industries. To meet the burgeoning demand for cocoa beans as chocolate consumption has grown rapidly in newly affluent countries, farmers have been forced into unsustainable production methods, including exploitation of farmers, migration into and clear-felling rainforests, growing cocoa as a monoculture without the traditional shade trees, and excessive use of pesticides.

This book promotes approaches to intensification of production on existing farms, including a return to diversified planting systems and use of shade trees, selection of higher yielding varieties that are less susceptible to pests and diseases, and use of cultural methods, such as control of tree size by pruning and breeding, sanitary removal and disposal of infested pods and branches, and use of organic soil amendments.

Compounding particular agronomic challenges on farms, poor economic returns to farmers, price volatility and lack of financial support deter farmers from investing in management of their existing farms and drive the exploitation of virgin forest and human labour that currently sustains cocoa production. Cocoa is at the centre of the current concern about the destruction of tropical rainforest in the cocoa growing countries and its

effect on climate change. It is also central to the problem of the extreme disparity in wealth between the cocoa processing companies of the temperate zone and the smallholder farmers of the tropical world, leading to a gross imbalance in the cocoa supply chain.

This book is about the biology, sociology, economics and management of a crop that is still in the process of domestication. It is also about the value-chain of an industry that is still developing from its exploitative colonial origins. Cocoa is grown largely by smallholders with minimal technology in post-colonial societies and is subject to boom-and-bust cycles of production governed by abrupt price fluctuations, and by environmental variation and pest and disease outbreaks in the producing countries. These cycles are disruptive to the cocoa-growing communities and the natural rainforest environment. While cocoa is a very valuable commodity, with many advantages for supporting real economic development in the wet tropics, as shown by the spontaneous cocoa booms that have driven rural development in parts of Central America, northern South America, Bahia State of Brazil, West Africa, Malaysia, Papua New Guinea and Sulawesi, it is still to find its real power to support stable economic development of tropical farming communities. From its earliest cultivation, cocoa has been treated as a pioneer crop, being grown in newly opened tropical rainforest areas where production using simple methods was successful for a period but then declined as the soil nutrients that had accumulated under rainforest declined, the trees became overgrown and senescent, pioneer farmers aged along with their cocoa groves, and pest, disease and weed problems built up; production centres then moved to new areas within regions, or even new regions. It has been said that cocoa production has involved ‘shifting agriculture’ on a national and international scale, mimicking on a longer time frame and wider geographical scale the shifting agriculture that for millennia sustained food crop production in tropical forests. But now the toll on tropical farming families and the limitations on the unfettered clearing of forest for planting cocoa and other tropical crops such as oil palm are becoming all too clear and production has to be stabilised and intensified on the land that has already been turned over to cocoa or other tree crops such as coconuts, leading to a stable and productive life for farming communities. As well, consumers are now less tolerant of the use of exploitative agronomic, economic and social practices to produce a product of such sophisticated cache as chocolate. Organisations are being developed to certify that cocoa production is environmentally and socially acceptable to increasingly enlightened consumers who are less inclined to accept a situation where chocolate production relies on destruction of rainforest and exploitation of farmers who often have an income well below the global

poverty line. The world demand for chocolate is increasing steadily as newly affluent populations in Eastern Europe, Asia and South America can afford to buy and appreciate chocolate, and this puts increasing demands on the environmental and human resources needed for growing cocoa beans.

Here we contend that sociology, politics and economics, along with agronomy and genetics, are the fields on which the battles for sustainable cocoa production have to be fought. Technologists work very hard to try to help farmers by manipulating the natural factors of the crop (its genetics, nutrition and management), but we as a society rarely attempt to manipulate the human-constructed economic value chain, which rewards the chocolate companies handsomely and farmers poorly, limiting their management options to grow the crop sustainably.

This is intended to be a practical book, dedicated to a common-sense approach to the production of healthy cocoa by healthy farming communities. It builds on the great books on cocoa biology and production, especially P.F. Entwistle 'Pests of Cocoa', C.A. Thorold 'Diseases of Cocoa', P.H. Gregory 'Phytophthora Diseases of Cocoa', G.A.R. Wood and R.A. Lass 'Cocoa', and the invaluable series 'Cocoa Growers' Bulletin', edited first by G.A.R. Wood and then by R.A. Lass for Cadburys, which should be referred to for the fine detail not covered here. It also revisits some of the older, pioneer books on cocoa such as C.J.J. van Hall's 'Cocoa' (1932), W.H. Johnson's 'Cocoa its Cultivation and Preparation' (1912) and E.C.W. Green's 'Cocoa Cultivation in Papua New Guinea' (1938) for their insights that remain important today and are often overlooked. Allen Young's poetic and philosophical book 'The Chocolate Tree. A Natural History of Cocoa' shows the enchantment of cocoa for the people who study it and has been an inspiration for the authors.

Here the aim is to use the detailed knowledge reviewed in these books as a foundation for developing straightforward and practical suggestions for improving and intensifying the production of healthy cocoa sustainably on existing farms, thus reducing the pressure to encroach further on rainforest, and to improve the profitability of cocoa farming as a way of life for the many millions of smallholder farming families who rely on the crop – to increase the profitability of cocoa production to the farm gate, and to increase the share to farmers of the value-chain leading to chocolate. The chocolate manufacturers, the market chain and consumers have to take on more responsibility for reducing the exploitation of farmers and forests. We believe that the knowledge and wisdom exist to allow the current smallholders who dominate cocoa production in the tropical countries to make a good living from cocoa farming, using their resources of land, labour

and farming skills, and maintain their traditional community-based cultures if they desire.

The book is intended to encourage local research in the cocoa-growing countries leading to increased profitability for smallholders. Areas for further study at a local level and the basic ideas of experimentation and farmer participation are included as a stimulus to research in the cocoa-growing countries where research is often difficult due to lack of resources and lack of support by governments. In this technologically driven world, it is often overlooked that all that is needed for good research is a curious mind, and an ability to observe, measure, count and analyse, all freely available in all countries. An important premise of the book is that our current fundamental knowledge of cocoa farming, as summarised here, is adequate for devising useful management measures, which have to be adapted and applied to suit local environmental and social situations.

A major problem is the lack of thorough application on farms of the existing knowledge and recommendations for the best production of cocoa as a way of improving the livelihoods of farming families. The book included ideas on how this deficiency can be addressed through participatory research and education of farmers. The book evaluates the solutions to problems that have a social, economic and political as well as a biological basis and whose solution is more likely to lie in the common-sense application of existing knowledge, accumulated painstakingly by farmers over centuries, and in changes in the political and economic environment of the crop, than in spectacular bio-molecular developments that are often touted as the magical solutions to complex agricultural problems. Yes, we have sequenced the cocoa genome, but what can this add to the existing practical knowledge of cocoa and its production systems that are so deficient in application on farms that the global average yield is only about 200 kg dry beans per hectare per year when 2000 kg is already known to be possible on smallholdings with improved methods? The approach we describe recognises that one of the main problems for cocoa production worldwide is the adverse socio-economic situation of cocoa farming, and the depressed plight of the farmers that leads to a host of concomitant problems such a lack of enthusiasm for cocoa farming of a younger generation of better educated and more flexible people. The current exploitation of farmers results in lack of application of, or improvement of, existing technologies, and over-use of short-cut methods of production such as exploitation of forests, complete removal of shade trees, exploitation of labour and poorly targeted use of pesticides. This book tries to put the smallholder farming family at the focus of endeavours to improve the production of cocoa by stable, healthy farming communities; it recognises

that the farm and the farmer can be the centre of research into, and development of, sustainable production of cocoa.

In many countries cocoa is seen as a ‘man’s crop’, having been developed initially on colonial plantations managed and worked by men or adopted as a smallholder cash crop that bolstered patriarchal societies. Managing and harvesting tall cocoa trees is arduous work. Reducing tree size makes it more amenable to more intensive ‘light-touch’ management by the whole smallholder farming family. Cocoa management, especially for pest and disease control, requires the attention to detail traditionally given by women to food crop production in village societies. The theme of this book is to promote this transformation in cocoa management from a foraged bush crop to an intensively managed horticultural crop, and discuss how it can be achieved for the long-term benefit of smallholder cocoa farming families, the cocoa and chocolate trade, the rainforests that are being clear-felled excessively to meet the world’s growing demand for chocolate, and the stability of the global climate that is affected by deforestation in the equatorial belt. To some extent the chapters are written as stand-alone essays, necessitating some repetition between them.

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This book is based on our experience in working to improve sustainable cocoa production and especially pest and disease management in collaboration with smallholder farmers in Indonesia and Papua New Guinea over many years. Working with academic and company partners, government extension staff and farmers has provided the insights on which the book is based and enabled the development of new and integrated approaches to sustainable cocoa production and improved livelihoods of farmers. Our thanks to the Australian Centre for International Agricultural Research (ACIAR) and collaborators who have supported cocoa smallholder development projects in Indonesia and Papua New Guinea for many years (2001 to 2022) and colleagues with whom we worked under these projects, for example on methods of farm-selection for pest and disease resistance in local cocoa cultivars and Integrated Pest and Disease Management (IPDM) methods. We also thank the Australia-Indonesia Centre (AIC) for its support of a livelihood study and pilot community empowerment program (2017-2019) for cocoa smallholders in West Sulawesi and our colleagues at Hasanuddin University, Bogor Agricultural University, University of Sydney, Indonesian Coffee and Cocoa Research Institute, Agricultural Technology Assessment Institute, Sulawesi Selatan and Mars Inc. We particularly thank the colleagues who worked with us on these projects, including Trevor Clarke, David Guest, Smilja Lambert, Hussin bin Purung, Jeff Neilson, Sahardi Mulia, Abdul Wahab, Imron, Suntoro, Kartika Fauziah, Nurlaila, Agung Susilo, Liz Sulistyowati, Sri Sukamto, John Bako Boan, Nunung Nuryatono, Sudi Nasir, Grant Vinning, Dian Sidik Arsyad, Andi Imam Arundhana, Sarina Alimuddin, Rauf Doel, Merrilyn Walton, Jim Roshetko, Ade Rosmana, Vien Sartika Dewi, Junaid, Amanda Firmansyah, Suli Hakim, Ayu Parawansa, and Besse Amriati. We remember the major contribution of the late Ashar Saftar (Mars Indonesia) to research on cocoa clone resistance and the late Danny Rahim (Plant Protection, Hasanuddin University) for all his help with ACIAR project research. Many thanks for informative interviews provided by cocoa sustainability managers in Sulawesi, including those at Swiss Contact, Rainforest Alliance, Rikolto (VECO), Olam, Cargill, Ecom, Barry Callebaut, Wasiat and Bridgewater, particularly Suharman Sumpala, Hasrun, Ibu Hani, Hermawan Wakiman, Peni Agustiyanto, Jeremy Hicks,

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Key informant interviews

Key informant interviews were conducted in June-August 2017 as part of a study supported by the Australia-Indonesia Centre (AIC) (AIC 2018; Arsyad et al. 2019) with cocoa sustainability managers in Indonesia (see above). Field studies for Masters research students at the Institut Pertanian Bogor (IPB), West Java were also supported.

ABBREVIATIONS

ACIAR, Australian Centre for International Agricultural Research
ACDI-VOCA, Agricultural Cooperative Development International-Volunteers in Overseas Cooperative Assistance
AIC, Australia-Indonesia Centre
BP, black pod (also called Phytophthora pod rot)
CATIE, Centro Agronómico Tropical de Investigación y Enseñanza
CCC, Le Conseil du Café Cacao (Coffee and Cocoa Council; Coffee Cocoa Board), Côte d'Ivoire
CCI, Cocoa Coconut Institute of PNG
CEPEC, Cacao Research Centre in Brazil
CEPLAC, Commissao Executiva do Plano da Lavoura Cacaueira (Brazil)
CIRAD, Centre de Coopération Internationale en Recherche Agronomique pour le Dévelopement
COCOBOD, the Ghana Cocoa Board
CPCRI, Central Plantation Crops Research Institute (India)
CPQP, Cocoa Productivity and Quality Program in Côte d'Ivoire (an IDH program)
CRIG, Cocoa Research Institute of Ghana
CRIN, Cocoa Research Institute of Nigeria
CRU, Cocoa Research Unit, University of West Indies, Trinidad and Tobago (now the Cocoa Research Centre)
CSSV, Cocoa swollen shoot virus
EST, Expressed sequence tags
FAO, Food and Agriculture Organization of the United Nations
FFS, Farmer field school
GAP, Good agricultural practice
GERNAS Kakao, Gerakan Nasional Kakao (National cocoa rejuvenation program in Indonesia)
ICCRI, Indonesian Coffee and Cocoa Research Institute
ICRAF, International Centre for Research in Agroforestry
ICM, Integrated Cocoa Management
ICQCR, International Cocoa Quarantine Centre at the University of Reading
ICS, Internal control system (also known as IMS)
ICS, Imperial College Selections, cocoa from Trinidad and Tobago

IDH, Sustainable Trade Initiative, Netherlands
IMS, Internal management system (certification)
IPDM, Integrated pest and disease management
IPM, Integrated Pest Management
LBC, Licensed Buying Companies (Ghana)
LG, Linkage group
LOD, Logarithm of the odds
MAS, Marker assisted selection
MCB, Malaysian Cocoa Board
PAR, Participatory action research
PCR, Polymerase chain reaction
QTL, Quantitative trait locus
RA, Rainforest Alliance
REDD, Reducing Emissions from Deforestation and Forest Degradation
SIT, Sterile Insect Technique
SNP, Single nucleotide polymorphisms
SSR, Single sequence repeats
STORMA, Stability of Rainforest Margins, German-funded studies in Indonesia on cocoa and other crops
ToT, Training of Trainers
USDA, United States Department of Agriculture
UTZ, former certification organisation (Utz capeh, Mayan for good coffee)
UF, United Fruit cocoa cultivars
WCF, World Cocoa Foundation

CHAPTER 1

THE BIOLOGY AND HISTORY OF COCOA AND CHOCOLATE

1.1 Introduction to cocoa

Cocoa (*Theobroma cacao*) is a small evergreen tree (Figs 1.1, 1.2, Centrefold A-C) whose seeds ('beans') produced in large fruits ('pods') are used to make chocolate. Like all cultivated plants, it has a fascinating social and botanical history. As a crop still undergoing domestication and emerging from its colonial past, its social and economic history is especially important and problematic, as discussed throughout this book. It is adapted to growing in the warm wet tropics and is cultivated mainly by an estimated 6 million smallholder family farmers in the equatorial regions of America, West Africa, Southeast Asia and the Pacific (World Cocoa Foundation 2012). It evolved as an understory tree in the rainforests in the upper Amazon River region of South America, at the junction of Colombia, Peru, Ecuador and Brazil, with another centre of evolution in the lower Amazon and Orinoco Rivers region of Brazil, Venezuela and Guyana. Here the species, still common in surviving rainforest either as scattered trees or in clumps, shows its greatest genetic diversity. Plant breeders can still explore these areas for new genetic resources to develop improved varieties (Motamayor et al. 2008).

As an understory rainforest tree, cocoa is adapted to growing in shade, and on farms is commonly planted beneath other trees (commonly referred to as 'shade trees') that can include remnant forest trees, planted fast-growing legumes (Fig. 1.4, Centrefold B) or other tropical tree crops such as coconuts (Centrefold C), rubber, oil palm, *Canarium indicum* (called 'galip nut' in Papua New Guinea), bananas, plantains or fruit trees. Cocoa can be a valuable component of mixed farming systems that mimic the great species diversity of natural rainforests with their many ecological advantages over monocultures in the wet tropics, especially for maintaining soil fertility (Chapters 5, 8). Under favourable conditions, cocoa can give high yields when grown without shade, although this requires greater management and fertiliser application and is unsustainable in the long term

(Ruf and Zadi 1998), as discussed later (Chapters 5, 8). The first well-documented cultivators of cocoa were the Mayan and Pipil-Nicarao people of the Central American isthmus, north of its centre of evolution, although anthropologists think it likely that it was first cultivated by the Olmec people before them (Young 1994, 17; Campbell 1976); it was then spread more widely as a cultivated plant throughout Spanish and Portuguese America after the European conquest and later to most equatorial regions of the globe during the European colonial era, acquiring slightly different common names in the various languages (Box 1a).

Figure 1.1 A small two-year-old Trinitario cocoa tree bearing red pods

Figure 1.2 A seedling cocoa tree bearing pods after 2-3 years

Box 1a. The naming of cocoa

The tree is known as ‘cocoa’ or ‘cacao’ in British English, 'cacao' in Spanish, French and American English, 'cacau' in Portuguese and Brazilian, 'kakao' in Indonesian and ‘kakau’ in Papua New Guinean, all names derived from its original Mayan name, ‘kakawa’, or Aztec name, ‘cacahuatl’.

Referring to the Mayan belief in the divine origin of the tree and its fruit and beans, the great Swedish botanist Carl von Linne (known as ‘Linnaeus’) in 1753 gave it the scientific genus name *Theobroma* (‘*Theo*’ – god, ‘*broma*’ – food, ‘Godly food’ in classical Greek), species *cacao*. In the British colonies, the name ‘cacao’ was used for the tree, and ‘cocoa’ for its products (cocoa beans, cocoa powder, cocoa butter) but now ‘cocoa’ is commonly used in English for both. The tree is not to be confused with the coconut (*Cocos nucifera*), the tall, elegant palm tree of equatorial coastlines, nor with the kola nut tree of Africa (*Cola acuminata, C. nitida*), nor with the coca bush (*Erythroxylum coca, E. novogranatense*) native to the Andes and the source of cocaine. *Theobroma* was originally classified in the family Sterculiaceae (along with *Cola* and *Sterculia*, the baobab or bottle tree), but based on modern taxonomy and DNA analysis, is now placed in the larger family Malvaceae along with cotton (*Gossypium* spp.), hibiscus, mallow, kapok (*Ceiba pentrandra*), jute (*Corchorus* spp.), and the Southeast Asian durian (*Durio* spp.) (Mabberley 2017; James 2004). A number of other *Theobroma* species and close relatives grow wild in the Amazonian rainforests but only *Theobroma cacao* is grown commercially on a wide scale. The large-flowered species, *Theobroma grandiflorum* ('cupuaçu'), is used in Brazil to produce juice, jam and ice cream from the sweet pulp surrounding the beans and the Brazilian premium chocolate manufacturer, Amma Chocolate, makes a chocolate from the beans (Bernardini 2015, 168).

1.2 Imbalance in the cocoa-chocolate value chain impacts both farmers and the environment

Cocoa is grown in the equatorial regions of the world that until about 1800 were mainly covered by tropical rainforests. These forests, which cover only about 7% of the world's land area, include more than half of the world's plant and animal species and occur mainly in the more economically deprived countries in Africa, Central and South America, Southeast Asia, Melanesia and the South Pacific. Cocoa cultivation has had a massive impact on these forests, matched only by conversion for cattle grazing and oil palm cultivation in recent times. Cocoa has been an important agent of deforestation especially during the twentieth century, accelerating greatly since 2000 mainly in West Africa. Global cocoa production has doubled from 2 to 4 million tonnes/annum since 2000, with most of the increase occurring in the rainforests of West Africa, now often involving complete clearing of forest and growing cocoa as a monoculture without shade (Fig. 1.3).

The Upper Guinean moist forests of West Africa constitute one of the great centres of biodiversity, home to a quarter of Africa's mammals, including 20 species of primate, and about 2000 endemic plant species (Myers et al. 2000). These forests once covered 600,000 km^2 but now only about 18% remain (Gockowski and Sonwa 2010). Most of the forest lands are now occupied by cocoa farms that produce nearly 80% of the world's cocoa and support 700,000 farming families in Ghana and 800,000 in Côte d'Ivoire. Initially, cocoa was grown in Ghana by only partly clearing forest and leaving large forest trees as shade. But more recently, more intensive production systems using Upper Amazon hybrid seedlings and added fertiliser have enabled farmers to completely clear forest trees and grow cocoa in full sunlight, giving a doubling in yield per ha in the short term. In the 10 years from 1996 to 2006, the perennial crop area (mainly cocoa and oil palm) in Côte d'Ivoire, Ghana and Nigeria expanded from 90,000 km^2 to 110,000 km^2, while the forested area contracted from 115,000 km^2 to 95,000 km^2. The annual deforestation rate in cocoa producing countries of 2% per annum roughly matches the rate of increased demand for cocoa by the chocolate consuming countries of 3% per annum.

Norris et al. (2010) pointed out the cocoa production in Ghana occurs almost entirely within areas identified as biodiversity hotspots and has been a major contributor to deforestations and loss of biodiversity. An investigation by the NGO Mighty Earth (Higgonnet, Bellantonio, and Hurowitz 2017) found that cocoa farming was encroaching on national parks and other protected areas in Ghana and Côte d'Ivoire. Less than 4% of Côte d'Ivoire's original dense rainforest remains and deforestation has

pushed chimpanzee populations into a few small areas and reduced the country's forest elephant population from several hundred thousand to less than one thousand.

Figure 1.3 Clear-felling of rainforest for cocoa farming

Some shade systems such as the cabruca system in Bahia, Brazil, or the original planting method in West Africa, where cocoa is planted in primary or old secondary forest in which trees and shrubs are thinned to about 10% of their original abundance and most lianas are removed, retain some elements of the virgin forest but they are still highly reduced (Rice and Greenberg 2000). Now, cocoa is being increasingly grown in dual cultures with planted leguminous shade trees such as *Gliricidia sepium* in which practically all of the original forest species have been removed (except for a few desirable species such as *Arenga* palm in Indonesia) or it is being grown as a complete monoculture without shade. The recent rapid increase in cocoa production in West Africa is mostly based on new plantings without shade, or at most a few remnant trees. In Sulawesi about 50% of the cocoa planted in the 1980s and 90s was on former forest land (Centrefold S) although much of the planting on coastal alluvial plains was on land previously cleared for other crops. In Sabah and Sarawak, Malaysia, 80-90% of the cocoa expansion occurred in rainforests, while in Peninsular Malaysia only 20% of the new plantings in the 1960s and 70s was on forest land; much was under coconuts or on land cleared for rubber and other crops.

Production of cocoa has doubled, and the area of forest turned over to cocoa farming has increased by over 2.5 million ha in the past 25 years,

mainly in West Africa and Indonesia (Rice and Greenberg 2000). Unfortunately, in the quest for higher yields and production to meet the global demand for chocolate, much of this cocoa expansion is grown without shade when cocoa farms with diverse shade have the potential to support some degree of local biodiversity. To reduce the negative impact of cocoa farming on rainforests and tropical biodiversity, emphasis has to be placed on developing methods of renewing plantings on old, declining or abandoned farms using diverse shade and other companion plantings that are useful to farmers, protect soils and support some biodiversity as well as taking the pressure off the demand for further clearing of forest.

While cocoa beans are produced in the tropical regions, mainly by smallholders using very simple technology, the commercial production of chocolate drinking powder and solid chocolate confectionery that drove the rapidly expanding demand for cocoa beans from the tropical colonies has been largely confined to the industrialized temperate world, defining the nature of the cocoa-chocolate commercial value chain to this day. The issues raised by this imbalance are addressed in the following chapters, to identify ways in which the disproportionate gap in rewards between producers (i.e. smallholder farmers) and the downstream conglomerates they support can be narrowed. As an example, cocoa grinding to produce cocoa powder and cocoa butter is becoming more important in some cocoa growing countries (Chapter 10).

To date cocoa has been grown by exploiting the fertility accumulated over decades in rainforest soils, and by exploiting the labour of village smallholders and migrant farmers seeking a better life. This era is ending, through the exhaustion of available forest resources, the desire to preserve remaining forests for the precious species they harbour (for example, the few remaining forest elephants, pygmy hippopotamuses and chimpanzees in Côte d'Ivoire) and for reducing global warming, and through the increasing negative social and political consequences in a more connected and politically aware world of exploiting the majority of human beings for the benefit of a few. Ruf and Zadi (1998) in a paper aptly titled "Cocoa: From Deforestation to Reforestation" suggest a way forward through combining the resourcefulness and labour of farmers living on their land, more extensive planting of trees to complement and support cocoa in agroforestry, diversified cropping systems (for example, using valuable palm, fruit or nut crops as shade for cocoa, and interplanting cocoa with other crops such as food crops, vanilla, black pepper and spices), judicious use of fertilisers, herbicides, insecticides and fungicides, and especially integrated cultural management methods, all supported by a less exploitative value chain that can provide farmers with the income to support good

management methods, and improved governance to support farmers in the cocoa countries. A highly valued commodity crop such as cocoa, supported by the whole value chain down to the affluent consumers, can drive its own transition from an agent of deforestation and exploitation of farmers from 1900 to 2020, to an agent of reforestation and restoration of tropical farmland, farming businesses and rural life through the 21st Century (Ruf and Zadi 1998). Cocoa has to transition from a little-managed, partly domesticated pioneer crop to a more intensively managed horticultural crop requiring less heavy labour but more regular careful attention, like that afforded to food crops especially by women in the cocoa countries. An important aspect of this transition is turning cocoa from an agent of exhaustion of older smallholder farmers to an agent for the invigoration and inspiration of younger farmers as it was in the early days of the cocoa booms in the various countries (Chapter 2). The great optimism and enthusiasm of pioneer migrant or village farmers taking up cocoa production on their 'own' land for the first time became dissipated after twenty or thirty years as prices received by farmers fluctuated and declined. This was often due to excessive taxation of farmers directed for 'nation-building' within the cocoa countries. Yields declined because of poor pioneer farming practices that led to soil exhaustion and build-up of pests, diseases and weeds. Labour demands increased as trees got too big while family labour resources declined as parents aged and children, educated with profits from cocoa, left home for the towns and cities. As Ruf and Zadi (1998) point out – "Farmers and their trees grow older together." This often drove migration to areas where new cheap land was available and the extractive and exploitative farming process could begin anew. But this option is now receding.

The admonition of R.G. Fennah (1958) at the 1957 Cocoa Conference in London still goes to the heart of the problem with cocoa farming:

> "First, let us remind ourselves that cocoa growing as at present practised is a soil-wasting process. The initial fertility of the land under newly cleared or selectively thinned virgin forest is not maintained by any system of cultivation that I have met or read about in cocoa. No balanced fertility is built up nor (probably far more important) are the initial forest water relations of the soil maintained. Even allowing for the upward trend in the consumption of cocoa products, the historical picture of the successive development of the cocoa-growing areas of the world is a glorified picture of shifting cultivation on a global scale. This, in large part, has been made necessary by the failure to devise an intensive and fertility-maintaining agronomy for cocoa. Shifting cultivation is simply running away from problems which appear too hard to solve."