

Establishment of First Gene Sanctuary in India For Citrus in Garo Hills

Bhag Singh

Foreword by

M. S. SWAMINATHAN



A great deal is talked about today regarding renewable and non-renewable resources of the earth. What is not often borne in mind is the fact that even the so called renewable resources are not nearly always so. Once the eco-system has been degraded so that the critical threshold is crossed, the process is irreversible. Recovery, if at all possible, may take centuries. Genetic diversity is the result of biological evolution over thousands of years. What is needed is the protection of whole eco-systems so that their diversity and that of their species can be ensured for their contribution to man's survival and well being. Mere protection of endangered species is not enough.

Hence the zeal for development among the nations of the world must be tempered by an equally fervent concern for maintaining environmental stability. Balanced integrated planning must anticipate the all round consequences from which both man and nature can benefit. Ideally, economic productivity should go hand in hand with environmental stability. Dr. Bhag Singh's monograph on the Citrus Gene Sanctuary highlights the efforts of Government of India towards the conservation of genetic diversity of this economic crop and the urgent need for such conservation. The north eastern Himalayan region is the natural home of the citrus species including *Citrus indica* which is believed to be the progenitor of the mandarin orange. This wild orange has a very wide adaptability under diverse conditions and could be useful for developing genetic stocks resistant to diseases and pests. Recent exploratory and ecological surveys have made it possible to identify a site in the Tura range in Garo Hills where the wild orange locally known as *Emang Narang* is found. This first Gene Sanctuary for Citrus in the world will

Contd. on next page



help to preserve the environmental conditions under which certain genotypes will flourish. It will also create an awareness to preserve such environmental wealth in the country.

This book should help to stimulate interest among educated youth in the genetic endowments of our country apart from its contribution to the literature on conservation and plant genetics.

BHAG SINGH (b. 1935) is an agricultural scientist by training and holds a doctorate in genetics from the Indian Agricultural Research Institute. He has spent more than twenty years of his life as a post-graduate teacher and researcher in this discipline.

Dr. Bhag Singh has been particularly interested in the indigenous plant wealth of the north eastern region of India inhabited by varied ethnic groups endowed with a rich culture and tradition of their own. Out of this grew his research study on the *Races of Maize in India* which earned him the prestigious Fakhruddin Ali Ahmad Award in 1979.

A member of several scientific societies he has contributed to important scientific journals and presented papers at various conferences. He has also participated in several national and international training programmes.

He is currently engaged in carrying out investigations towards the establishment of the First Gene Sanctuary for Citrus in the Garo Hills as the Officer-in-Charge at the National Bureau of Plant Genetic Resources, Shillong, Meghalaya.

ESTABLISHMENT OF FIRST GENE SANCTUARY IN INDIA
FOR CITRUS IN GARO HILLS



The author is seen receiving the Fakhruddin Ali Ahmad Award for Agricultural Research in Tribal India from Begum Abida Ahmad.

ESTABLISHMENT OF FIRST GENE SANCTUARY IN INDIA FOR CITRUS IN GARO HILLS

BHAG SINGH

National Bureau of Plant Genetic Resources



Foreword by

M.S. SWAMINATHAN, F.R.S.



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634.30954164

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First Published 1981

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Bhag Singh (b. 1935-)

Published by
Naurang Rai
Concept Publishing Company
H-13, Bali Nagar
NEW DELHI-110015 (India)

Printed by
Patel Enterprises
at Sunil Printers,
1067, Ajay Palace, Naraina
New Delhi-110028

F237
1066

Foreword

GENE segregation, recombination and mutation provide opportunities for the occurrence of extensive genetic variability in all living organisms. This forms the basis for the popular statement "variety is the spice of life". Depending upon environmental and biotic factors, different genotypes survive under the most hospitable conditions. Human selection and interference can change the situation and to-day we find that many plants and animals thrive well under conditions which are totally different from those occurring in their original habitats. The frontiers of adaptation have been extended by man. At the same time, human interference with the habitat requirements of different species has also accelerated the pace of species extinction. O.H. Frankel and M.E. Soule in a recent book on *Conservation and Evolution* published by the Cambridge University Press, have stated: "Throughout the history of life, there has never been as wanton nor as rapid an agent of habitat destruction as Twentieth Century man". Every species being only as safe as its habitat, there is a grave danger of our losing valuable genetic material if steps are not taken to protect the natural habitats of wild species or make alternative arrangements to conserve natural variability. The rate of destruction of tropical forests to-day has been estimated at about 47 hectares per minute. At this rate the tropical forests will become historical curiosities within a century.

Frankel and Soule have classified the various factors which contribute to species extinction as follows :

1. Biotic factors
 - (a) competition
 - (b) predation
 - (c) parasitism and disease
2. Isolation

3. Habitat alteration

- (a) slow geological change
- (b) climate
- (c) catastrophe
- (d) man

In recent years, organised arrangements for the collection and conservation of crop genetic resources have been streamlined. The International Board for Plant Genetic Resources (IBPGR) organised by the Consultative Group on International Agricultural Research in 1974 has been successful in stimulating and co-ordinating international concern for crop genetic resources. Presently the IBPGR is dealing with 120 species of food plants and other plants of global or regional importance. At a recent meeting the following priority areas have been identified in relation to the programmes of IBPGR :

- additional cold stores for seed conservation should be provided to strengthen the international network ;
- the use of tissue culture techniques should be expedited for conservation of clonal materials, probably guided in the first phase by an IBPGR expert working group;
- work on the characterization and evaluation of germplasm in genebanks should be speeded up and the findings transmitted to potential users ;
- basic informational data should always be sent out with samples.

The conservation programmes of IBPGR as well as the National Bureau of Plant Genetic Resources of our country have largely centred around annual crop plants. Fruit and forest trees are yet to receive similar attention. In many cases *in situ* conservation is the best method of preserving the variability in the wild species of potential value to man. This kind of conservation is akin to the conservation of natural eco-systems. In eco-system conservation, the emphasis is on representativeness of particular communities within the eco-system as a whole. In long-term reserves such as the biosphere reserves, the time scale of concern is infinity. Attempts are now being made particularly in the United States and the

USSR to protect the endangered plant species which occur usually in restricted sites. There is, however, need for the more widespread establishment of genetic reserves or gene sanctuaries in which wild relatives of crop species can be protected and the population biology of individual species can be studied. The studies of Dr. Bhag Singh, which form the basis of this book, relate to the preservation of the variability in *Citrus* in the north-eastern Himalayan region. Dr. Bhag Singh has in particular dealt with in detail the potential for conserving the genetic wealth of *Citrus indica* in the Tura range of the Garo Hills in Meghalaya. We are fortunate in our citrus wealth. The north-eastern Himalayan region has also proved to be a veritable mine of valuable genes in many other crops including rice and maize. Unfortunately due to the practice of shifting cultivation or *jhuming* and widespread habitat destruction, much of this genetic wealth faces the threat of extinction. We, therefore, owe a debt of gratitude to Dr. Bhag Singh and the National Bureau of Plant Genetic Resources of the Indian Council of Agricultural Research for their timely initiative in surveying the habitat of *Citrus indica* and suggesting a plan for conserving this unique genetic wealth for posterity.

Yojana Bhawan
New Delhi-110001
14 October 1981

M.S. SWAMINATHAN
Member
Planning Commission

Preface

THE INFORMATION given in this publication was gathered at the regional station of the National Bureau of Plant Genetic Resources, at Shillong, financed by the Indian Council of Agricultural Research. The investigations pertaining to the establishment of a Citrus Gene Sanctuary in Meghalaya were initiated in 1978 at Shillong.

The investigations summarised in this book pertain to the preservation of the native habitat of the wild orange (*Citrus indica*) a progenitor of the mandarin orange. It is hoped that this book will help to stimulate interest among the youth in the genetic endowments of our country.

This project was conceived by Dr. M.S. Swaminathan, F.R.S., former Director General of the Indian Council of Agricultural Research and Secretary, Department of Agricultural Research and Education, presently Member, Planning Commission and Chairman, Science Advisory Committee to the Cabinet. He used the term "gene sanctuary" for stressing the need for preserving the environmental conditions under which certain specific genotypes flourish. His efforts made it possible to identify the wild orange faced with danger of extinction in this part of the world. This concept was vigorously implemented with his collaboration.

My wife Smt. Balwant Kaur and my son Shri Irvinder Singh left no stone unturned to familiarize themselves with the tribals which laid the foundation to initiate the work of these systematic exploratory surveys. Their active participation and encouragement were my main source of inspiration. My wife could not accompany me in the later part of the project due to ill-health.

A committee of experts headed by Dr. B. P. Pal, F.R.S. Chairman, National Committee on Environmental Planning and Coordination, approved the proposal based on exploratory

and ecological surveys for the establishment of a Citrus Gene Sanctuary in Meghalaya. Subsequently, in 1980, the ICAR constituted a Task Force under the Chairmanship of Shri J.C. Nampui, I.A.S., Chief Secretary, Government of Meghalaya to work out an operational blue print for the establishment and development of this sanctuary. Recently, the blue print of the site has been prepared.

Many people have helped in various ways, to all of whom I should like to express my sincere thanks. The work would not have been possible but for the keen interest, able guidance and constant encouragement of Dr. O.P. Gautam, Director-General ICAR and Secretary, Department of Agricultural Research and Education. I am also equally indebted to Dr. K.L. Mehra, Director, National Bureau of Plant Genetic Resources for his keen interest, able guidance, constant encouragement and for providing all the facilities during the research work.

I wish to express my gratitude to the officials of the Government of Meghalaya for their painstaking efforts towards the establishment of the First Gene Sanctuary in India for Citrus in Garo Hills. I wish to express my gratitude for their cooperation, generous help, guidance and valuable suggestions during the present investigations. My special thanks are due to Shri L.P. Singh, former Chairman, North Eastern Council and Governor, and Chief Minister, Meghalaya for their support and encouragement.

I am thankful to Dr. B.P. Pal, F.R.S., former Chairman NCEPC; Dr. D.N. Borthakur, Director, ICAR Research Complex for North Eastern Region; Dr. S.Z. Quasim, Secretary, Department of Environment; Dr. H. K. Jain, Director, Indian Agricultural Research; Dr. J. Joseph, Deputy Director, Botanical Survey of India; Dr. P.S. Ramakrishnan, Professor of Botany, North Eastern Hill University for help, guidance and valuable suggestions. I am deeply indebted to Prof. M.G.K. Menon, I.A.S., Secretary, Science and Technology for valuable suggestions and to Shri N.D. Jayal, I.A.S., Joint Secretary, Department of Environment for his keen interest, valuable suggestions and guidance since the inception of these studies. I am also thankful to the other staff of Science and Technology for their helpful suggestions.

I wish to express my deep appreciation for the valuable help and cooperation extended by the staff members of National Bureau of Plant Genetic Resources. I wish to thank especially Prof. M.W. Hardas and Dr. R.K. Arora.

I am grateful to Col. S.M. Chadha, Director and Shri K. Baburajan, Survey of India and other staff members for their help and cooperation.

I am thankful to Dr. R.R. Misra, Prof. of Botany; Dr. Asket Singh, Deputy Director, Zoological Survey of India for their help. My sincere thanks are also due to Dr. S. K. Jain, Director and staff members of Botanical Survey of India, Howrah, Shillong and Dehra Dun and Forest Research Institute, Dehra Dun for their help and for providing facilities to use their herbaria.

Among those to whom I owe indebtedness for constant encouragement and inspiration, the name of Smt. Mina Swaminathan deserves special mention.

Finally, the National Bureau of Plant Genetic Resources does not hold responsibility for the opinions expressed in this book, such responsibility rests with the author alone.

BHAG SINGH

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Introduction

SOME believe man as a force above nature. The Creator required man's active and rational participation for His plans. Although man is selfish and shortsighted, he is not irrational. His self destruction was no more ordained than his felicity was supposed to have been. If he has the capability to ruin nature, he might also mend it. It is true that the welfare of future generations matters more than any immediate considerations. Anyone wielding a hoe or an axe knows what he is doing but more important is it to assess the cumulative effect of all axes and hoes. Man unequivocally depends on nature which includes soil, water, plants and animals. He unwittingly destroys the supporting fabric of nature in obtaining them. It is therefore essential to understand the effects of environment. This will help to restore and maintain the natural environment as long as man tenants the earth. Civilized man has committed ravages and destroyed the balance which nature has established between organic life and inorganic matter. The earth was given to man for usufruct alone, not for consumption, still less for profligate waste. Nature has left it within the power of man irreparably to derange the combinations of organic life and the inorganic world. The organic and inorganic matter are bound together by mutual relations and adaptations in a long continuum of the established conditions of each at any given time and place.

The geological causes whose actions cannot be guided are partially responsible for the decay of flourishing countries. But the direct violence of hostile human force has the manifold role to ruin the fairest and most fruitful nature. This could be due to man's ignorant disregard of the sophisticated laws

of nature or may be the incidental consequences of war and of civil tyranny and misrule. It is but recently that man has awakened and felt the necessity of restoring the disturbed harmonies of nature, whose well-balanced influence is so rewarding to all her organic world. Man is a uniquely potent creature of the ecosystem hence continued efforts should be made to provide him and his successors with the means to live and to improve their lot upon this earth. The conscious changes brought about by the races that inhabit the regions of the world are the products of complicated forces which not only alarm the physical balances but organic creation also. While every effort is being made to increase productivity one should not ignore to conserve and enhance the quality of the ecosystem.

Haphazard systems in agriculture are often found in many parts of the world. Historically, agriculture and forestry are looked upon as competitive and not complementary activities. It is conceded that forests were cleared to make room for agriculture, the world over. The farmers took the trees as their enemies and preferred to grow their crops in isolation with potential competitors ruthlessly removed. The advanced countries and the developing countries including India have suffered from ecological as well environmental damage resulted from expanding civilization. Every step taken by mankind towards progress has only increased its dependence on nature. The advancement in civilization coupled with increased population, by and large, has definitely threatened the life supporting systems. Forests do not serve the needs only of the local communities but also people far beyond. Developing countries like India have suffered irrevocable damage by destroying innumerable diversified trees in the quest of food, fuel and fodder. The North Eastern Himalayan region comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim is not an exception. This region is primarily inhabited by the tribals practising the age-old methods of 'Shift cultivation' or 'Jhuming'. In this method people find it absolutely necessary to clear the forests to provide food for their very existence and obviously this causes the mountain ecosystem to be denuded of natural vegetation. The clearing of the forests is made during the winter months

and burning starts with the summer, for a year or so, then the yield of the crops slows down and a new forest is brought under this practice. The tribals are considered the custodians for the fascinating genetic wealth, since the north-eastern region is primarily inhabited by them. These tribals are yet in the wake of development which obviously also posed the need for clearing forests for the construction of a communication network and an increased demand for construction purposes.

There has been a great concern recently to locate and preserve the wild relatives of cultivated plants. The wild sugarcane variety, *Saccharum spontaneum* proved to be the most useful stock in saving the sugar industry from disaster caused by a virus disease. Vavilov (1950) in his note on the "The phytogeographic basis of plant breeding" has indicated "It is natural that the first step in breeding should be the maximum utilization of local material, the segregation of their most productive and valuable forms. The success of breeding in our country (Russia) in recent years has been chiefly based on this segregation of the most valuable forms from local population. Our best varieties of winter and spring wheat, rye, flax and barley produced in recent years by our breeding stations, are chiefly the results of selections from local varieties". About 60 years ago N.I. Vavilov demonstrated the scientific and economic significance of conservation of plant genetic resources. Subsequently, it tended to be more widespread. Consequently, an International Board for Plant Genetic Resources is now functioning under the aegis of the Consultative Group on International Agricultural Research. The IBPGR in a systematic, scientific and sustained manner has led to the identification of priorities and action programmes in the collection, evaluation and conservation of plant genetic wealth.

India is endowed with immense agri-horticultural crops. The natural diversity of many crops prevails in the forests i.e. for *Citrus*, *Musa* and *Mangifera* in the north-eastern Himalayan region. It was proposed to plan systematic studies for preserving the pockets of such habitats where considerable genetic variability occurs in economically important plants. It was urged to preserve the important materials by way of gene sanctuaries. The gene sanctuary is a mechanism to preserve

the genetic diversity of endangered species by protecting the ecosystem in which it occurs naturally.

The citrus fruits which include oranges, limes, lemons citrons rank third in acreage among the sub-tropical fruits of the world. The orange, lemon and lime are known for their taste and daily domestic use. The loose skinned oranges with known speciality are called mandarin oranges. Because of deforestation, several natural growing species are facing the danger of extinction. Nature is the best conservatory, but due to man's encroachment it is dwindling fast. Consistent efforts are being made both at national and international levels to identify and to preserve such useful variability. It is well recognized that the judicious use of the natural resources alone can save mankind from unforeseeable disasters.

There has been an increasing stress in the conservation area where systematic scientific efforts will have to be supported by social and political consciousness and action. A classical example of such a conservation has been set at Leningrad during World War II. The Vavilov All Union Institute of Plant Industry which had a rich collection of germ plasm of wheat potato etc. continued to grow during the war in order to preserve them. Seemingly, these were the only crops growing in the area wherein the citizens were suffering from acute hunger. A large number died due to starvation. It is to their great credit that neither potatoes nor grain were stolen by anyone from the fields or gene bank of the Vavilov Institute of Plant Industry. This is the richest tribute which one could possibly render to the work of Vavilov and to the spirit of conservation. It is precisely this type of social commitment to the conservation of genetic wealth that needs to be generated (Swaminathan, 1980).

Although there is a pressing need for assuring food for today under no circumstances can we afford to forget to conserve and direct resources for the benefit of the generations yet to be born. Sustained agricultural advances will not be possible without ecological security designed to protect and to conserve fauna and flora, soil and water and environment. In 1980, the World Conservation Strategy was launched under the overall leadership of the International Union of Conservation of Nature and Natural Resources which laid great

emphasis on the preservation of genetic variability in living organisms.

The conservation of plants cannot be postponed any longer. The collections can be made in seed, cutting, bulb or any other storage organ or in some cases it may necessitate the removal of the entire individual from the natural habitat—off site. In other cases it may be essential to preserve the plant in its natural habitat—on site.

It is but recently in 1978, under the auspices of the National Bureau of Plant Genetic Resources that a project for setting *in situ* *Citrus* gene sanctuary was sponsored and financed by the Indian Council of Agricultural Research. The renowned national herbaria of the Botanical Survey of India at Shillong, Howrah and Dehra Dun and the Forest Research Institute, Dehra Dun were intensively studied to review the past work pertaining to *Citrus*. These studies revealed the presence of more than 23 *Citrus* species in India. This study included the information regarding the number of *Citrus* species prevalent particularly in India, their time and place of prevalence, including elevation, climatic features, topography and other characteristics of their natural habitat. Information like local name(s) of the variety, uses and the collector's name and address were also collected. Systematic detailed exploratory surveys were made particularly of the centres of diversity to study the extent of each citrus species. A major emphasis was made on the wild and rare species. The study of mandarin orange particularly was unavoidable.

In view of the fact that the north-eastern Himalayan region is abundantly endowed particularly with the indigenous *Citrus* species, dedicated efforts were made to study this region with vast and varied diverse problems. It was observed that *C. macroptera*, *C. latipes*, *C. ichangensis*, *C. assamensis* and *C. indica* were found in the semi-wild and wild states. These are found in different pockets at varied elevations. All except *Citrus indica* are prevalent and hence do not need any particular attention for their protection. The recent ecological surveys conducted by me in the north-eastern Himalayan region have made it possible to locate an area in Tura Range in Garo Hills where *C. indica*, an endangered species, occurs. This species is the most primitive and perhaps the progenitor

of cultivated citrus materials. The importance of wild citrus fruits like *C. indica* can hardly be over-emphasised. These materials, by and large, are adaptable to diverse climatic conditions and could be useful in providing wide genetic stocks for developing varieties resistant to diseases and pests. The investigation revealed that *C. indica* trees in the dense forest had flowers and fruits and were relatively more prolific than those found at the periphery. Closely resembling climbers of this species were also encountered casually in the dense forests. This wild primitive type of citrus species can maintain its character and flourish well in the dense forest. The frequency distribution of this species was recorded in its natural habitat.

In order to allow the populations to follow the same line of natural evolution, on site preservation in the natural environment is essential. It is not possible to restore the whole spectrum of ecological conditions elsewhere if these are removed. The incompleteness of environmental conditions coupled with genotypes that are submitted to continuous alterations by recombination of genetic material, selection will follow different lines from those in nature under self created conditions. These are some of the tangible evidences in favour of *in situ* preservation of variability of *C. indica* in Meghalaya. Detailed studies were carried out to identify an ideal site for preservation of *C. indica* in the natural habitat on a model similar to that of biosphere reserves elsewhere. The Tura Range in the Garo Hills in Meghalaya has been considered the most ideally suitable for the establishment of the first gene sanctuary in India for *Citrus* in Garo Hills as biosphere reserve. The site was approved by the experts committee.

The site forms a part of the Tura Range which is one of the largest ranges in the Garo Hills in Meghalaya. The area of the site is about 10265.96 ha which has been delineated on maps indicating boundaries. The Garo Hills are characterised by a dense cluster of hills of low elevation with a central ridge traversing from the north-west to south-west known as Tura Range. Many of these hills are below 600 metres in altitude except in Arbella Range where the elevation reaches 960 metres and in the central range which maintains a fairly even altitude of 1200 metres. The highest peak is Nokrek which is 1412 metres high.

The present site of the gene sanctuary as biosphere reserve has the following characteristic features :

1. It is a unique area with unique communities of exceptional interest. It has the centre of distribution of rare or endangered species, *C. indica* in the forest with natural protective barriers.
2. It has a natural genetic diversity for the rare species, *C. indica* which is a primitive one and has the priority.
3. It would be an effective conservation unit.
4. This site is an undisturbed area.
5. It will have long-term legal protection.
6. It will provide opportunity for ecological research education and training.

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NEW DELHI