INTRODUCTION

Historical Background of Orange Cultivation

Orange being one of the important citrus fruits of the world occupies a prominent place in the horticultural field. Numerous forms of citrus have been growing from hoary past in Assam and it also abounds in wild forms. Assam is also considered to be the creator centre of citrus flora of India. Assam enjoys a prominent privilege in the production of orange covering 10.8% of total area of the country under orange cultivation and has attained the third position in the country. Average orange yielding per hectare in Assam is 11.0 MT/HA while in all India, it is only 7.3MT/HA.

Citrus cultivation dates back to many centuries. This cultivation is said to be started in China as early as 2200 BC. South China and Assam are the origin of many citrus fruits. The citrus fruits include lime, lemons, and oranges. Bhattacharya and Dutta (1956) opined that limes, lemons and Citrus reticulate are indigenous to Assam.

A broad analysis of the history and development of citrus is found in the book ‘The Citrus Industry’ Vol-I edited by Walter Ruther. As mentioned by Herbert John Webber in his article “History and Development of the Citrus Industry” in the said book the first member of the group of citrus to have known to European civilization was the ‘citron’ mentioned about 310 B.C. by Theophrastus. For several hundred years, this was the only citrus fruit known. The sour orange, the lemon and the sweet orange were discovered in a much later period. As far as preserved literature indicates, this last species i.e. sweet orange was not known in Europe until approximately 1400 A.D. In connection with the evidence of the existence of sweet variety of oranges Webber observes:

However, on the basis of careful examination of a Pompeian tile mosaic, Tolkowsky (1938) presented strong evidence that the orange tree possibly of the sweet variety was grown in Italy prior of Pompeii in 79 A.D. A tile floor mosaic found in a Roman Villa near Tusculum (modern Frascati) indicates that soon thereafter lemons and limes were also known in Italy. (1967:1)

Archeologists and historians believe that by the beginning of the first millennium Chinese farmers set aside land for orchards where oranges, apples, figs and a variety of
other trees of other fruits were grown. Oranges and apples in particular were very popular amongst the nobility and orchardists were known to compete with each other for the pleasure of their lord by growing ever larger, sweeter, or more perfectly rounded and colorful fruits. It is now known that the sweet orange had been grown for many centuries in China and had apparently reached an advanced stage of cultivation before it became known to Europeans. The history of citrus fruit is fairly long. One of the best-known early books is about the oranges of Wen-Chou, literally: *Kee Jia Citrus Record* (Citrus records of Ji Jia) written in 1178 AD by Han Yanzhi the governour of the region. The book was translated in 1923 by Michael J. Hagerty as Monograph on the oranges of Wen-Chou, Chekiang. It describes the 26 citrus varieties grown in the region, their cultivation techniques and use. He also described citrus, kumquats and the trifoliate orange and discussed nursery methods, grove management and diseases. (Webber: 1967).

Though the records say that the fruit is believed to be originated in China, the cultivation of orange was found in almost all the other parts of the world. The cultivation extends contribution to the economy of the producing countries.

It was the Arab traders who initiated to spread oranges through the Mediterranean areas. The Portuguese, the Spanish, the Spaniards, the French all indirectly or directly contributed to the spread of oranges as a part of their trade purpose to different countries during the middle of the 16th century. The medicinal value of the fruit was given importance in the European countries. Combined with the medicinal value its luscious quality inspired wealthy persons to establish orange orchards.

An important observation was made by Webber that it was Columbus who transported oranges to America in 1493. The same fact is supported by Historia de las Indias by Bartolome de Las where it is mentioned that Columbus sailed from the Bay of Cadiz on his second Expedition on September, 25, 1493 to America and carried citrus seeds on the sail.

As observed by Webber, the naturalist Oviedo Y Valdes wrote that four orange trees from Castile were brought to Santo Domingo they had multiplied abundantly. Later on, the orange cultivation travelled to West Indies, Brazil, the world’s largest producer of oranges. Brazil was introduced with this cultivation by the Portuguese
traders. In the first half of the seventeenth century, the accounts of Spanish and Portuguese voyagers contained many reference to the spreading of citrus in the new world. Webber also mentioned about a Spanish book entitled Historia del nuevo mundo (History of the New World) by Bernata Cobo (1580-1657) where it is mentioned that by the second half of the 17th century the varieties of orange were available in Spain.

Leibbrandt (1897) and Webber (1925) provide evidence of the introduction of oranges in South Africa by 1650s. The record was found in a collection of journals preserved by Von- Riebeeck, the first governor of the Dutch colony at Cape Town. The first orange trees were brought on June 11, 1654 and planted in the private garden of the governor on July 25, 1661. It was also stated that there were 1,162 young oranges, lemon and pomelo trees that grew in the garden of the said Governor.

F.T. Bowman (1955) in the book Development of Vigorous NSW Citrus Industry by pioneer horticulturists in the hill districts records that orange was first introduced into Australia in 1788. It is also mentioned that orange, limes and lemons were flourishing during first year of its settlement. It is also important to note that Australia started trade on orange with China. Not only that as early as 1860 the oranges were marketed under the name of Bahia or Naval orange initiating the citrus Industry in California.

The first reference of the appearance of oranges in Florida is found in a statement by Pedro Menendez marquez to the Audiencia of Santo Domingo San Augustine in 1579. The record shows that oranges were produced in abundance in 1579 thirteen years after the settlements in St Augustine of Florida. After 1579 two major orange groves were established in Florida viz. Mays Grove and DD Dummitt Groves which were used as home for collecting seeds and seedlings. The extensive orange cultivation was spread from these two groves in various places in Florida. Now orange is recognized as a globally commercial fruit resulting in the consideration of orange as a symbol of Florida. Florida’s license plates have a picture of a couple of oranges. The world famous fruit juice company ‘Tropicana’ was founded by a man named Anthony Rossi. Slogan of the Tropicana Company ‘A day without Florida orange juice is like a day without sunshine’ reflects the globally recognized commercial value of orange.
Stressing on the history of citrus cultivation in California Ching Lee in his article ‘The History of citrus in California’ notes that the first commercial citrus from planted by William Wolf Skill in 1840 was considered to be the ‘granddaddy’ of California’s citrus business. As found in the manuscript of Clavigero the cultivation of orange in California dates back to the settlement of Spanish missionaries in Southern California during the 1700s. Webber (1967) observed an interview of William Spalding, a newspaper reporter with father Jouquin Bot, the priest at the mission. The interview records the planting of first orange orchard by 1804. Webber quotes:

In 1862, there were about 25,000 orange trees in the state, but by 1882 bearing trees had increased to over half a million (Butterfield, 1963), fruit industries languished and well-nigh perished. The third great impetus to the extension of the citrus industry in California came in the late 1870’s and early 1880’s with the completion of three transcontinental railways in the Southern Pacific Valley Line in 1876. It connected the Central Pacific and Union Pacific to the East, the southern line of the Southern Pacific to New Orleans in 1881, and the Santa Fe in 1885. These railways provided competing carriers for eastern shipments and had an immediate effect on the industry. (1967:21).

To trace the origin of orange cultivation in India reference can be made to a collection of devotional text entitled Vajasaneyi Samhita assigned to a period prior to 800 BC. The name used for lemon and citron was as Jambila. As observed by N R Mankad in his book Citrus in India (1996) comments that the names for oranges appear in The Charak Samhita dated 100 A. D. E. Bonovia in his book The Cultivated Orange and Lemon writes:

‘In Baber’s memoirs the following occurs, which is stated to have been said by Humayoon: “In Bengal there are fruits which have an acid flavor, though they are not of equal excellence with the amratpha (sweet lemon). The one is kamilah, the other is the samtereh, and are larger than the orange, but are not sour. The latter is found in Bengal at one village, called Senargam, and even in Senargam it is found in the greatest perfection only in one place. There is no pleasanter fruit than the samtereh.”’ (1890:44)

Roxburgh (1832) in the Flora Indica recognized orange, Kamala or Santra in the name c aurantium. Hooker (1855) in his Flora of British India placed sweet orange,
mandarin orange of the Khasi Hills, Garhwal and Sikkim within a single species as c. aurantium. Brandis (1874) in Forest Flora of North West and Central India included loose skinned orange, tight skinned orange and bitter orange in a single species of c. aurantium.

R C Woodford in his book Citrus Classification refers to WT Swingle’s classification of orange family. (2005:10) Swingle accepted C. reticulate for mandarin orange. The retention of the name c. reticulate was applied by Blanco in 1837. The loose skinned oranges are recognized as citrus reticulate Blanco.

The word ‘mandarin’ is derived from the French word ‘Mandarine’ meaning a golden fruit brought by Angel. This loose skinned orange and has synonyms like Mikan in Japan; Mandarina in Italy; Ponkan in China and Batanga in Philippines (Deshmukh 2007)

Most of the taxonomists seem to agree that Cochin China, the southernmost region of the Indo-Chinese Peninsula is the birth place of the mandarin orange (Tolkowsky, 1938). Brandis (1874) reports that the mandarin orange was found wild in Garhwal and Kamaon in Uttarkhand, Sikkim and the Khasi Hills and Manipur.

In Assam, during the British period Assam Agricultural Department inaugurated the citrus Fruits Research Scheme at Byrnihat, financed jointly by the Indian Council of Agricultural Research and the Govt. of Assam in 1938. Investigation process under this scheme was carried out for ten years. As a part of the scheme considerable data have been collected and compiled about orange. Different species of orange were recognized with specific scientific names.

The Khasi orange on Khasi mandarin (C. reticulate Blanco) has been in existence in this North East part of India from hoary past, whether it is indigenous to Assam or it was introduced to the state no historical evidence is available to support any one of the views. As observed by Bhattachrya and Dutta (1949:40) if it was introduced it might have travelled to Assam in a period of silent barter known to have seen in existence between the hill people bordering Yun-nan province of China, Upper Burma and Assam. The Shans of the Yunnan province carried out a series of invasions in the Brahmaputta Valley from the eight century and completely occupied the area in the thirteenth century (Mc Mahon, 1886). It is quite likely that the Shans might have brought with them fruits or seeds of this luscious fruit and planted the same with success and the variety thus became gradually feral in Assam. The systematic orange
cultivation started during the Ahom period in upper Brahmaputra Valley. There is probability of spreading the cultivation of orange in the lower Brahmaputra valley from the Khasi Hill specially in Kamrup.

The Khasi name soh-niamtra, the Assamese name Sumthira or Sumathira, Bengali and Oriya- Kamala, Gujarati & Hindi- Narangi, Santra, Tamil- Kadago, Telego- Kamalaapondhu and the common Indian name as Santra, Suntra or Sunitra for the mandarin orange have got a perceptible phonetic semblance in the first part with the word san indicating a common origin.

The derivation of the Assamese word sum-thira (pronounced as humathira) according to the Hem-Kosh (Assamese Vernacular Dictionary) is that the first part of the word sum (corruption from the word ‘shon’) means gold and the second part of the word thira (corruption form the word ‘tara’) means star. As the ripe orange in the tree looks like the golden stars from a distance, hence it is called sum-thira.

It is quite likely that the Bengali name kamala for loose skinned orange might have originated by corruption from the Burmese name ‘kambala’ or the Chinese name ‘kam’ for the fruit indicating a foreign origin.

In Kamrup district of Assam especially in Sonapur area the name of the Khasi mandarin has been recognized as ‘kamala’ ‘sumathira’ and ‘sontora’. At the time when the oranges are ripened the area surrounded by the hillock are glimpsed with golden star. It may be the reason that ‘Sontara’ is the popular name of orange in this region. Some of the local people also call it Mitha Tenga meaning sweet citrus.

**Geophysical Environment of Orange Cultivation**

The citrus belt of the world ranges from 15° to 40° North latitude and South latitude from Equator on both sides. This includes mostly sub- tropical and some part of semi tropical zone. Citrus growing Countries falling in the range of 15° to 40° North latitude are Japan, China, India, Pakistan, Algeria, Turkey, Spain, Italy, France, Portugal, Mexico, Cyprus, USA, Egypt and Israel. On the other hand, 15° to 40° South latitude covers the countries like Australia, Chile, Brazil, South America, Mozambique, Switzerland, Venezuela, New Zealand, South Africa, Argentina etc.

Some of the principal countries of tropical and subtropical regions growing oranges on a large scale are Brazil, USA, China, Spain, Mexico, India, Italy and Egypt.
Climatic Environment of Major Orange Growing Countries of the World

Brazil: Brazil is situated at a distance of 5,320 km from north to south, 4328 km from east to west. Brazil has a land frontier of 15,719 km., and on Atlantic coastline of 7,408 km. Topography of Brazil can be divided roughly into five zones:

i) The Amazon Basin ii) the River Plate Basin iii) the Guiana Highlands iv) the Brazilian Highlands and v) the Coastal Strip.

The Amazon Basin is densely forested and it covers 40 per cent of Brazil’s territory. It receives heavy rainfall and is flooded annually. The average temperature of the Amazon Basin is 27°C with no seasonal variation.

The River Plate Basin in southern Brazil is less heavily forested and the climate is cooler.

The Guiana Highlands north of the Amazon are part forest and part shrub land.

The Brazilian Highlands, lying between the Amazon and the River Plate Basin form a tableland from 300 metres to 900 metres high. There are a few mountain ranges.

Coastal Strip covers the Atlantic coastal areas.

The average temperature range is 17 °C to 19 °C. The two winter months in the south are June and July. Humidity is relatively high in Brazil, particularly in the Amazon basin and on the Coast. The rainy season in North is from January to April, it is from April to July in the North-east and the southern coastal area experiences rain from November to March end.

In Brazil, oranges are grown everywhere in the coastal plain and in the highlands extensively in the northern and southern region. Orange culture rose sharply in States of Sao Paulo and Rio de Janerio in the years immediately following World War II and the same is still advancing. In the region of Campinas, Sao Carlos, Sao Jose de Rio Preto, Barretos and Western part of the state of Minas Gerais are important areas of orange growing in Brazil.

USA: Total geographical area of the United State of America is 9,00,000 square km. It stretches from the North Atlantic Ocean to the North Pacific Ocean.
The western part of the country is dominated by the two major mountain ranges, viz. the Rockies and the Sierras. In the eastern, the lower Appalachian and Allegheny Mountains provide the western boundary to the coastal plain. The lowest part is Death Valley; the highest point is Mount McKinley. The mid-west, the central part of the country is a vast plain where the major agricultural products are grown. So, this area is known as the breadbasket of the USA.

Alaska has mountains and broad river valleys.

The size of the land area and the natural mountain barriers give a wide variety of climate. It is tropical in Hawaii and Florida; arctic in Alaska; semi-arid in the Great Plains west of the Mississippi river and arid in the Great Basin of the south-west. California has a Mediterranean style climate with mild winters and hot summers. The south and Gulf areas have a semi–tropical climate. The east coast and the mid-west are very cold in winter and very hot in summer.

In California average temperature is 63° F (17.22° C) maximum, 28° F (-2.22° C) minimum. In arid hot desert region the maximum temperature lies 112° F to 115° F (44.4° C to 46.11° C) and minimum 18° to 20° F. (-7.77° C to -6.66° C) Rains occur in the months of November to April.

In Florida climate is tropical, rainfall occur in each month with a maximum from May to September.

Major Orange growing areas of USA are concentrated in California, Florida, Arizona and Texas.

**China:** Yellow and East China Seas connects China to the east and the South China Sea to the South.

Deserts and semi arid grasslands make up much of the western and northern parts of the country. Central and eastern China is the most heavily populated parts of the country. The plains of north and northeast China are flat and fertile, but these areas frequently suffer from prolonged drought.

Mountain ranges occupy 33 per cent of the areas of China. Most of the rivers run west to east. The largest (widest) river is the Yangtze, followed by the Yellow river. The Yangtze River is known as Chiangjiang (Long River) in China.
China has an extremely diverse climate with tropical areas in the south contrasting with the subarctic north and mountainous Tibet. Most of China, especially coastal areas has a relatively temperate climate. The average temperature there in summer is 20\(^0\)C in winter the average temperature is southern and central China is about 4\(^0\)C. Most rain falls in summer.

Major Orange growing provinces of China are Guangdong, Sichuan, Zhejiang, Fujian, Hunan, Guangxi, Hubei, Jiangxi and Sichuan.

**Spain:** Spain covers 504,782 square km. including the Balearic Islands in the Mediterranean Sea and Canary Islands in the Atlantic Ocean and the Ceuta and Melilla enclaves in North Africa. It occupies most of the Iberian Peninsula, sharing it with Portugal to the west.

Most of the Spain has a Mediterranean Climate with mild winters and hot summers, although the mountainous north is colder and wetter.

Maximum temperature of Spain is 14.44\(^0\)C in January to 28.33\(^0\)C in July while minimum 5\(^0\)C in January to 20\(^0\)C in July.

Rainy seasons occur from the month of September to April with rainfalls of 8\(/\) to 23\(/\).

Major oranges growing areas of Spain are Burriana, Southern Andalusian region, Seville and Granada.

**Mexico:** Mexico comprises of an area of 1,958,201 square km with a variety of terrain lowland jungle to high Alpine vegetation. The arid soil structure of the land is so rich that it can support three crops a year.

The northern border of Mexico is with the U.S., the border in the south and east is with Guatemala and whiles the border to the east with Belize. The northernmost portion of Mexico is covered by two different deserts namely Chihuahuan and Sonorant desert.

Northern and Central part of Mexico framing with a group broad Central Plateaus is known as the Altiplano Central. The central plateau is mostly rolling hill and broad valleys and includes some of the best farm and ranch land in the country. South of the Altiplano central range there are active volcanoes.
The Tropic of Cancer cuts across Mexico near Mazatlan and Ciudad Victoria and south of the tropic. It is hot and humid all the year along the coastal plains on either side of the country. The hot, wet season runs from May to October.

The southern parts of both coastal plains as well as the Yucatan Peninsula have a yearly median temperature between $24^0\text{C}$ and $28^0\text{C}$ ($75.2^0\text{F}$ and $82.4^0\text{F}$).

Mexico has both wet and dry seasons. Most of the country experiences a rainy season from June to mid October and significantly less rain during the remaining of the year. Average rainfall 5 millimeters ($0.2^{/ /}$) to 160 millimeters ($6.3^{/ /}$).

Important orange growing areas of Mexico are Veracruz, Tamaulipas, San Luis Potosi, Puebla, Nuevo Leon, and Sonara.

**Egypt:** Egypt has a land area covering 1,001,449 square km. It is predominately desert and has coastline on both the Mediterranean Sea and the Red Sea along with the Gulf of Suez and Gulf of Aqaba. Only 35,000 square km. about 3.5 % of the total land area is cultivated and permanently settled. Most of the country lies within the wide band of desert that stretches eastward from Africa’s Atlantic coast across the continent and into Southwest Asia.

Egypt’s major physical regions are - i) Nile Valley and Nile Delta, ii) Libyan Desert or Western Desert, iii) Arabian Desert or Eastern Desert and iv) Sinai Peninsula.

Nile Valley and Nile delta is the most important region being the country’s only cultivable regions and 99 % of the population. The Nile Valley is known as Upper Egypt while the Nile Delta region is known as Lower Egypt. Egypt is characterized by a hot season from May to October and a cool and winter season from October to May. In the coastal region average annual temperatures is ranged from a maximum of $37^0\text{C}$ ($99^0\text{F}$) to a minimum of $14^0\text{C}$ ($57^0\text{F}$). Average annual rainfall is about 200 mm and the season is from December to March.

Orange is the winter fruit well suited in two geographical regions the fertile Delta area and the newly reclaimed lands. New lands of Sharkia, Ismailia and Behara, middle and Upper Egypt are important orange growing areas in Egypt.

**Italy:** Total area of Italy is 301,230 square km of which 294,020 square km is land and 7,210 square km is water. Italy has a coastline on the Adriatic, Lonian, Tyrrhenian and
Ligurian Sea. The southwestern corner of the country is enveloped by Tyrrhenian Sea, while the north eastern part by Adriatic Sea. The south eastern Lioni an Sea and the Ligurian Sea located in North West Italy encircle the country from all possible sides.

There are two mountain ranges namely the Alps and the Apennines. The Apennine mountain range surrounding the northwestern parts of Italy meets the Alps.

The Italian plain known as the Padan Plain is drained by the longest river of Italy the Po and its numerous tributaries and distributaries, mostly flowing down from the Alps and Apennines to join it.

While Italy lies in a temperate zone, the climates of the north and south vary; summers are uniformly hot although summers in the south can be extremely hot and dry. In the winter, the south is generally mild while the north can be extremely cold; particularly near the Alps and Po valley. Temperatures range from about 4\(^0\)C to 30\(^0\)C. Temperature is very high in the months of July- August. The minimum temperature during those periods is 20\(^0\)C to maximum 29\(^0\)C. Coolest months are from December to March with an average temperature of 5\(^0\)C to 12\(^0\)C. The north has the most rainfall, with the wettest months being October to December with average rainfall 85 mm to 110 mm.

Major orange growing areas are Sicily, Calabria, Apulia, Basilicata, Campania and Puglia.

**Iran:** Iran is located in southwest Asia and borders the Gulf of Oman, Persian Gulf and Caspian Sea. The mountains enclose several broad basins or plateaus, on which major agricultural and urban settlements are located. Total area of Iran is 1,648,000 square km. Ira has only two expanses of lowlands the Khuzestan plain in the southwest and Caspian Sea coastal plain in the north. There is no major river in the country. Out of the small rivers and streams among them Karun, Kharkes, Tigris and Zayandeh are important.

Iran has a variable climate. In the north west, winters as cold with heavy snowfall and subfreezing temperatures during December and January. Spring and fall are relatively mild while summers and dry and hot. In the south, winter is mild and the summers are very hot, having average daily temperatures in July exceeding 38\(^0\)C (11\(^0\)F).
In general, Iran has an arid climate in which most of the relatively scant amount precipitation falls from October through April. In most of the country yearly precipitation averages 250 mm (9.8") or less. The major exceptions are the higher mountain Valleys of the Zagross and the Caspian coastal plain, where precipitation averages at least 500 mm (17.7") annually. In the western part of the Caspian rainfall exceeds 1,000 mm (39.4") annually.

The southern seaside lands of the Caspian Sea of the country produces finest conditions for citrus. Oranges are grown in the Mazandran province, the South Khorasan province and Bushehr province.

**Indonesia:** The total land area of Indonesia is 1,919,317 square km. Indonesia is an archipelagic island country in Southeast Asia lying between the Indian Ocean and the Pacific Ocean. It encompasses an estimated 17,508 islands, out of which 6,000 are inhabited. It comprises five main islands: Sumatra, Java, Borneo, Sulawesi and New Guinea. Most of the larger islands are mountainous with peaks ranging between 3000 and 3,800 meters above sea level in Sumatra, Java, Bali, Lombok, Sulawesi and Seram. Tectonically, Indonesia is highly unstable. It lies on the Pacific Ring of Fife where the Australian Plate and the Pacific Plate are pushed under the Eurasian Plate where they melt at about 100 km. deep. A string of volcanoes stretches from Sumatra to the Banda Sea. While volcanic ash has resulted in fertile soils, it makes agricultural conditions unpredictable in some areas. Of the 400 volcanoes, approximately 150 are active.

Indonesia’s climate tends to be relatively fairly constant round the year. The country experiences two seasons: a wet season and a dry season with no extremes of summer and winter. The wet season falls between October and April with the dry season between May and September.

The average temperatures in the coastal plains is 28° C (82.4° F) and in the inland and mountain area it is 26° C (78.8° F).

In Indonesia citrus is grown in West Kalimantan, Tristeza, Tlelung, Bali East Jave, Kabupaten, Buleleng, Selayan Island in South Sulawesi, South east Sulawesi, Buton Island etc.

Major oranges growing Countries and their areas, rainy season and the major seasons for availability of the oranges in the markets are shown in the Table 1.1
### Table 1.1
Major Oranges Growing Countries, Areas, Rainy and Harvesting Seasons

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Country</th>
<th>Growing Areas</th>
<th>Rainy Season</th>
<th>Major Harvesting Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brazil</td>
<td>Sao Paulo, Rio de Janeiro, Campinas, Sao Carlos, Sao Jose de Rio Preto, Barretos and Western part of the state of Minas Gerais.</td>
<td>January to April</td>
<td>December to March</td>
</tr>
<tr>
<td>2</td>
<td>USA</td>
<td>California, Florida, Arizona and Texas.</td>
<td>November to April</td>
<td>November to February</td>
</tr>
<tr>
<td>3</td>
<td>China</td>
<td>Guangdong, Sichuan, Zhejiang, Fujian, Hunan, Guangxi, Hubei, Jiangxi and Sichuan.</td>
<td>July to April</td>
<td>November to February</td>
</tr>
<tr>
<td>4</td>
<td>Spain</td>
<td>Burriana, Southern Andalusian region, Sevile and Granada.</td>
<td>December to April</td>
<td>October to December</td>
</tr>
<tr>
<td>5</td>
<td>Mexico</td>
<td>Veracruz, Tamaulipas, San Luis Potosi, Puebla, Nuevo Leon, and Sonara.</td>
<td>May to September</td>
<td>December to April</td>
</tr>
<tr>
<td>6</td>
<td>Egypt</td>
<td>Delta area, Sharkia, Ismailia and Behara, middle and upper Egypt.</td>
<td>December to March</td>
<td>November to February</td>
</tr>
<tr>
<td>7</td>
<td>Italy</td>
<td>Sicily, Calabria, Apulia, Basilicata, Campania and Puglia</td>
<td>October to December</td>
<td>November to February</td>
</tr>
<tr>
<td>8</td>
<td>Iran</td>
<td>The southern seaside lands of the Caspian Sea, The Mazandaran province, the South Khorasan province and Bushehr province.</td>
<td>October to April</td>
<td>November to January</td>
</tr>
<tr>
<td>9</td>
<td>Indonesia</td>
<td>West Kalimantan, Tristeza, Tlekung, Bali East Jave, Kabupaten, Buleleng, Selayan Island in South Sulawesi, South east Sulawesi, Buton Island.</td>
<td>October to April</td>
<td>November to January</td>
</tr>
</tbody>
</table>

*Source: National Horticultural Board & web.*

**India:** In India climatic regions suitable for citrus growing can be classified as follows

i) **South India (Karnataka, Kerala, Andhra Pradesh, Tamilnadu)** The hilly area of Coorg (Karnataka), Wynad (Kerala), Nilgiri, Yerachud, Palmis (Tamil
Nadu) etc. are the important areas of Coorg mandarins cultivated with rain fed. In this areas MSL 650 to 150 m., rainfall in two season on the S.W. monsoon and N.E. monsoon of 150 to 250 m. Temperature maximum 35\(^{0}\)C to minimum 11\(^{0}\)C.

The plains areas of Andhra Pradesh, Karnataka and Tamilnadu in dry climate rainfall only 25cm in July, December from S.W. and N.E. monsoon; the crops of Satgudi, Mosambi, Batavian Sweet orange, Kamala, Santra, Kagzi, lime etc. are produced.

ii) Central India (Madhya Pradesh, Maharashtra) Vidarbha, Marathwada and Khandesh, Nagpur, Pandhurna, Warud Morshi belt has excellent climate for Nagpur Santra, Sweet orange and lime.

iii) North India (Arid plains of Punjab and North Rajasthan) In this region elevation is MSL 220-300M Rains 35-50” while RH 50-54%. Temperature is maximum 52\(^{0}\)C to minimum 2\(^{0}\)C. Malta, Kinow, Mandarin etc. are grown in cooler climate of sub-montane tract.

iv) North East India (Assam, Meghalaya, Mizoram, Nagaland, Manipur, Tripura, Arunachal Pradesh and Sikkim). Citrus is grown more on hill slopes. Rain is 250 cms and more while MSL 1500 mm or even more. Soils of valley are loamy and of hills is laterite. Khasi mandarin is confined up to an altitude of 1200 m above mean sea level. Citrus in the region is grown under a high range of humidity throughout the year. The Brahmaputra and the Barak are the two principal rivers that govern the network of drainage system. The climate is humid subtropical and the annual rainfall varies from the heaviest at Cherrapunjee in Meghalaya (average 11420mm) to the lowest at Lumding in Assam (average 980mm). Mean minimum and mean maximum temperature are 18.3 and 29.9\(^{0}\)C respectively. While mean summer and mean winter temperatures vary from 24.6 to 32.8\(^{0}\)C and 9.9 to 24.8\(^{0}\)C respectively.

Northeast India is mainly divided into three meteorological subdivisions, viz. Arunachal Pradesh with average annual rainfall of 2997 mm, Assam and Meghalaya with average annual rainfall of 2497 mm, and Nagaland, Manipur, Mizoram and Tripura with average rainfall of 2314 mm. Physiographically, the entire North Eastern region is divided into four well-differentiated units:
1.2 India: Orange-Growing Areas
a. **Eastern Himalayas:** It is the eastern most part of the Himalayas and lies within Arunachal Pradesh. These areas have plenty of rivers, rivulets, water reservoirs, streams which descent from north to south, and gravitate to Brahmaputra valley.

b. **Eastern Mountain Region:** This region encompasses parts of Arunachal Pradesh viz, Tirap, Lohit and Changlong; eastern part of Assam, whole of Nagaland and Mizoram. The region is dissected by number of rivers viz., Barak, Doyang and Tuivai and rivulets. These rivers are typical mountain streams flowing in between Rocky Mountains interspersed with channels leading to narrow valleys. Mountain range among other things embodies Tripura-Cachar plain, Barak, Surma and Imphal valleys.

c. **Meghalaya Mikir Tableland:** It covers the Mikir hills, Garo hills and Jayantia hills of Meghalaya.

d. **Brahmaputra Valley:** The entire Assam valley lies in the length and breadth of the Brahmaputra River. It lies within the girdle formed by the eastern Himalayas, Patkai, Naga, Garo, Khasi, Jaintia, and Mikir hills. The valley varies in width from 90 km in upper Assam to about 55km near Mikir hills and it is about 725 km in length. The northern bank is characterized by tarai to semitarai conditions having innumerable tributaries and proximity with the Himalayas. On account of low gradient and high annual sedimentation, the Brahmaputra River gives rise to large number of riverine islands that cause periodic flood in Assam.

**Mandarin Varieties (C. Reticulata Blanco) in India:** Presently there are five varieties of mandarin commercially grown in India.

**Khasi Mandarin:** It is originated in Assam and especially in Jayantia and Khasi Hills of present Maghalaya. It is the most popular and a commercially widely cultivated variety of Assam and North Eastern States. Trees are medium to tall, straight upright, thorns or thorn less; dense foliage fruit weight 140 to 200 gm., colour yellow to dark orange, sweet in taste, peel thin and tight and acidity 0.30—0.35 percent.

**Darjeeling Santra:** It is grown in West Bengal especially in Darjeeling, Kalimpong hill areas. The seedlings are propagated by seed. It is more or less the similar with the Khashi Mandarin.
**Nagpur Santra:** It is loose skinned Mandarin, excellent in taste and flavour. It is the most widely cultivated commercial variety in India. The pulp is tender, saffron or orange colored with excellent blend of sugar acid.

This variety has been found since the last 250 years in Vidarbha. As observed by, P P Deshmukh, P.S. Joshi (2007) Raje Raghoji Bhosle brought it from Aurangabad to Nagpur in 18th century. It has spread in entire Maharashtra, Madhya Pradesh, part of Uttar Pradesh and Ganganagar District of Rajasthan. The santra belt of Nagpur and Amravati District is declared as export zone and it is called as California of India. Fruits are tighter in beginning but become loose if harvesting is delayed.

**Coorg Mandarin:** It is the commercial old variety of South India, especially grown in Karnataka, (Coorg) and Tamil Nadu (Wynad). Propagation is by seed and recently it has been done by budding. Tree is tall, big with a few thorns. Fruits are round, orange colored with dark orange juice. Sugar Acid blend in fruit is very good. Acidity is 0.57 percent. Fruit is oblate to globose. Crop is late in maturity. Coorg Santra is now cultivated as irrigated crop in Karnataka in plains.

**Kinnow:** Kinnow is hybrid of two citrus viz. king (*citrus nobolis*) and willow leaf (*deliciosa*). As observed by Hui, Cano and Barta (2006:312) this variety was developed by Dr. H.B. Frost in 1915 at Riverside California, USA and released for commercial cultivation in 1935. It is grown widely in California, Arizona of USA, Pakistan and North West India. It was first introduced in Punjab in 1940. It has spread to Himachal Pradesh, Haryana and Tarai region of UP and parts of Rajasthan. The tree is tall and looks like Mango, canopy dense and circular, fruits are borne inside canopy. This fruit has the advantages of rare sunburn, with attractive dark orange or orange red color, long storage value and minimum loss of transportability because of thick and tight skin.

It is mainly used for juice industry. Yield /tree per year were 575 at Katol and 315 at Akola in Maharashtra. Mandarin flowering and harvesting seasons in India are shown in the table 1.2. Soil Structure Suitable for Orange Growing in India: Ghosh (1985:170) points out the details of soil structure and climate suitable for orange cultivation in his article entitled “Citrus” in the book Fruits of India, Tropical and Subtropical. Citrus can grow well in a wide range of soil. Soil properties like soil reaction, soil fertility, drainage, free lime and salt concentrations etc. are some of the
1.3 North East India: Orange-Growing Areas.
### Table -1.2

**Flowering and Harvesting Seasons of Mandarin Orange in India**

<table>
<thead>
<tr>
<th>Area</th>
<th>Crop</th>
<th>State/ place</th>
<th>Flowering Time</th>
<th>Season/ Bahar</th>
<th>Duration of Harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>South India</td>
<td>Coorg Mandarin</td>
<td>Karnataka, AP, TN.</td>
<td></td>
<td></td>
<td>Nov.-March, June, Sept- Oct.</td>
</tr>
</tbody>
</table>
important factors that determine the success of citrus cultivation. It thrives well in deep, loose, well aerated soils devoid of any hand pan layers of calcium carbonate in the rooting zones. Ideal pH for citrus is considered to be between 5.5 to 7.5 but evidences show that with suitable management it can be grown with success in highly acidic (pH 4.5) soils and those containing free lime (pH 8.5). It is also highly sensitive to moist soil conditions within its root-zone and excellent growth of citrus had been observed in areas where water table is considered detrimental to citrus orchard health, while defective drainage causes nutritional imbalance. Citrus trees are susceptible to salt injury and they cannot thrive well in saline alkaline soil.

In India, while major mandarin orange growing belt of north eastern hills comes under acidic soil of sandy to clay loam nature, the other very famous mandarin growing belt of Nagpur region comes under non-acidic and heavy black soil. It appears that loamy soil with comparatively heavier subsoil or even heavy soil with good drainage arrangement can be ideal for citrus.

Assam is rich in having diverse types of soil ranging from alluvial on the plains and to late rite gravelly soil on the hill slopes. The sandy soil in the high rainfall areas is suitable for growing mandarin orange. The importance of nutrition for citrus will become clear when the quantity of nutrient element removed by citrus fruits from the soil is considered. Chapman (1947) reported that 18,000 kgs of citrus fruits remove 21 kg nitrogen, 5 kg phosphorus, 41 kg, potassium, 19 kg calcium, 3.6 kg magnesium, 2.3 kg sulphur, 45 gm boron, 9 gm copper, 50 gm iron, 13 gm manganese and 13 gm zinc. This shows roughly the magnitude of demand that orange trees make on the soil for its normal growth and development.

**Climatic Condition Suitable for Orange Growing in India:** Citrus belongs to the tender evergreen subtropical group and thrives well in frost-free subtropical to semitropical climate. However, occasional light frost can be tolerated by most of the citrus species. Being evergreen, citrus has no specific requirement for winter chilling, but cessation of growth actively during winter months help in flower bud induction, resulting to spring flowering. Different citrus species exhibit a range of tolerance to temperature fluctuations and the total heat during the growing season is extremely important for normal growth and productivity of various citrus species and varieties. The climatic factors like temperature, moisture, rainfall and atmospheric humidity with
light intensity are of principal importance for citrus of which temperature plays the key role. The temperature ranges from 55°F to 100°F (12.78° C to 37.78°C). In the winter, the ideal temperature range is 35°F to 50°F (1.67°C to 10°C). Usually, a low temperature or 20°F – 40°F (-6.66°C to -4.44°C) is considered to be injurious to young trees, while mature old trees die at a temperature about 12°F to 16°F (-11.11°C to -8.88°C). Hot winds and excessive heat hamper flowering. It is also highly detrimental for the fruit set period for good bearing. It causes fruit drop and sunburn affects the fruit. Atmospheric humidity maintains the physical characters of fruits where temperature affects colour of the fruit. Low humidity usually favours better colour development of fruits, while in light humid conditions the fruits are juicier with thin rind. Citrus is considered as a light loving plant and the trees are sensitive to shading. Trees under shade are usually poor fruit production but partial shading often results in higher fruit quality. Under higher mean of temperature condition citrus fruits mature early, fruit size is bigger and the development in the fruit juice remains lower. Different climatic factors influence the vegetative growth of citrus plants as well as the productivity and chemical characteristics of citrus fruits. The period from flowering to ripening also varies considerably based on the climatic environment of different locations. In case of the mandarin orange if grown at lower altitudes of north-eastern region, the fruits are matured by November-December. But when grown in cooler and higher altitude, the harvesting time is February-March.

*Santra* can endure high temperature up to 47°C (116°F) in Vidarbha and North Rajasthan. Hot summer can sunburn the fruits, develop granulation, and reduce juice content, young fruits drop due to high temperature and dry air during the period from April to June. Minimum temperature which citrus can endure depends on variety, age and root stock. However, 0°C or below temperature is dangerous.

In Vidarbha region of Central India excessive heat is experienced from April to second week of June. Climate from July to January is suitable for mandarins. Proper distributions of rain is important than total rainfall. Well distributed 700 to 800 mm. rain is adequate. However, if irrigation is given in semiarid subtropics, 600 mm. rains are sufficient. Heavy rain two months before harvesting deteriorates fruit quality enhances insects. Attack from disease is also heightened.
1.4 Assam: The Study Area, Kamrup District (Undivided) and Tinsukia District
1.5 Kamrup District: Location of Orange Growing Areas
1.6 Kamrup (M) District: Location of Orange Growing Areas
1.7 Tinsukia District: Location of Orange Growing Areas
Significance of Study

Fruit being the focus of study serves as a natural source of dietary fiber, vitamins and minerals. Therefore, its importance cannot be overlooked in developing countries like India for improving income and nutrition status particularly of rural masses. As the level of income has improved in the recent years people become more conscious about nutritious and healthy food habits. As a result the demand for fruits is also gradually increased in India and N.E. States. Henceforth, horticultural industry has a unique role to play in the health and economy of the people of our country.

International trade liberal policy of India opens various border trade transit points in NE region. It has initiated trade linkage with South Asian neighbouring countries thereby generating more prospects to export oranges. Investment in orange cultivation will create opportunity of employment, income and export promotion in the near future particularly in Assam and NE States.

In this context, reference can be made to Brazil, Chile and Kenya. Brazil’s agro-sector has been benefitted with economic liberalization in early 1990s. Given higher investment and substantial research and development effort Brazil has opened a scope to enter in the field of horticulture. Brazil has emerged as a major producer of citrus and exporter of Frozen Concentrated Citrus Juice (FCUJ). Brazil has even been able to capture the market of Florida and California the leading orange producing countries in the world. Chile has emerged as the largest fruit exporter of the world. The country has utilized its favorable agro climatic condition and low-labor cost with private sector investment and international assistance in developing infrastructure and technology. The increased demand for fresh fruits, vegetables and flowers and the quality of these products made a great contribution in Kenya’s success in horticulture.

In India major producing states of oranges are Maharashtra, Madhya Pradesh, Meghalaya, Orissa, Mizoram, Rajasthan, Assam and West Bengal.

The production of various fruits in the North Eastern States is a major thrust area in horticultural study. Among them Assam enjoys a prominent privilege in the production of orange, banana and pineapple. Assam produced 37% of orange, 78.55% of banana and 47.88% of pineapple among the N E States. Assam alone accounts for 10.8% of total area of the country under orange cultivation and has attained the fourth
position in the country with a production of 89,920 MT in the year 2007-08 while it became 141,800 MT in the year 2009-10.

In Assam, orange grows in almost all districts. It is important to note that average orange yielding per hectare in Assam is 11.0 MT/HA while in all India it is only 7.3MT/HA.

More prospects are there in the economy of Assam for this largely produced fruit, suitable for climatic as well geographical condition, having higher productivity, with higher food and medicinal value, having higher market demand, etc. It is observed that orange orchards have been scattered in different parts of Assam from long past in both hilly and plain areas. The existing orange orchards are run traditionally without proper technological up-gradation and proper investment.

From the statistical source, it is found that the total area of orange cultivation has been extended in the recent years. But in reality, from the field investigation it is found that the major orange orchards of Tinsukia and Kamrup districts have been diverted to tea plantation.

There is a long gestation period between the initial investment and first output in orange cultivation as a perennial crop. It has only a limited flowering period. It can provide good outcome only with the maintenance throughout the year. Moreover, inputs applied to it in one period affect the output in subsequent periods also. Therefore, precise estimation of economic parameters necessitates the inputs and outputs for the entire life span on it.

Taking account of the above considerations this study tries to focuss on the orange production economics with the help of economic tools of investment analysis through project evaluation techniques to measure profitability accounting and investment decision in the field of orange cultivation as a perennial crop.

There is also wide disparity between the price received by the cultivators and the actual market price of oranges. This wide disparity may be due to many reasons. Among them, pre-harvest and post-harvesting management is very crucial. Pre-harvest management not only helps in total production it also significantly helps in quality and store life of the produce. In post-harvesting management handling in plucking, grading, packaging for transportation, storage, processing and marketing etc. are important for a
perishable horticultural product like orange. Percentage of losses of orange at various levels during production like injury at the time of plucking, rupturing and bruising of the fruits during sorting at wholesale market, pressing and bumping of fruits in the retail level etc. becomes the major criteria to focus in the economic appraisal.

**Objective of the Study**

The study is designed with the following objectives

i) to assess the present status of orange cultivation in respect of allocation of area, production and productivity;

ii) to study a few socio-economic aspects of the orange growers in the study region;

iii) to assess costs and returns from orange cultivation in the study region;

iv) to assess the profitability from orange cultivation through investment appraisal methods;

v) to assess the present marketing costs of orange of the orange growers;

vi) to assess the present pre-harvesting and post-harvesting losses in various levels.

To achieve the objectives of the study, the following hypothesis are considered:

1. Historically, the areas in the Brahmaputra Valley are suitable for production and productivity of orange cultivation as horticultural crops.
2. Investment in orange cultivation is profitable as perennial crop.
3. Marketing of oranges by the orange growers is quite traditional for orange cultivation.
4. Existing system of post harvest management is not satisfactory for marketing of oranges.
5. Pre-harvest and Post-harvest losses are considered as vital factor of lower profit earn from the orange cultivation.
Methodology

The methodology is analytical and descriptive. Both quantitative and qualitative approaches are followed. The main purpose of this section is formulating a methodology comprising of

- Sampling Procedure
- Nature and sources of data
- Analytical techniques.

1.1. Sampling Procedure

The procedure adopted for collecting sample for the study is designed as follows:-

1.1.1. Selection of Study area

Two districts of Assam viz. Tinsukia from Upper Brahmaputra valley and Kamrup from Lower Brahmaputra valley are selected purposively for field study. The reason behind this is that Tinsukia covers the highest area and productivity while the oranges of Kamrup are better in taste and quality than that of other districts in Assam. As the Kamrup district is fragmented in two districts namely Kamrup and Kamrup (M) and both are important for orange production, therefore finally the three districts are considered for the study.

1.1.2. Selection of the Sample Cultivators

1.1.2a. Kamrup District

In Kamrup, there are three Sub-Divisions namely Guwahati, Boko and Rongia. Among these three sub-divisions majority of the orange growing areas are concentrated in Boko sub-division. Under Boko sub-division there are seven Agriculture Development Officers’ (ADO) circles namely Chaygoan, Garoimari, Boko, Borgoan, Bongaon, Nagarbera and Sontali. Out of this seven ADO circles Boko, Borgoan and Bongoan are the prominent areas of orange cultivation. Therefore, a total number of 30 orange growers, 10 from each of these three ADO circles are selected purposively as sample for collecting the primary data for the purpose of the study.
1.1.2b. Kamrup (M) District

In Kamrup (M) district there are four ADO circles namely Khetri, Sonapur, Satgoan and Dharapur. Among the four ADO circles Khetri, Sonapur and Satgoan areas are prominent for cultivation of oranges in the Kamrup (M) district. Therefore, a total number of 30 orange growers are selected randomly 10 from each of these three ADO circles of the Kamrup (M) district.

1.1.2c. Tinsukia District

In Tinsukia district there are three Sub- Divisions namely Margherita, Tinsukia, and Sadia. Among the three Sub- Divisions Tinsukia Sub- Division there are seven ADOs circle namely Bardubi, Hapjan, Doomduma, Kakapathar, Dhula, Philobar and Talap. Among them Kakapathar, Philobar and Hapjan are the prominent orange growing belts of the district of Tinsukia. Therefore, 10 from each of these three ADOs circles are selected amounting to 30 sample form the Tinsukia district also.

1.2. Nature and Source of Data

Information is collected on the following aspects from each orange grower through interview with the help of a well designed questionnaire during 2011-2012.

1. Area under orange groves;
2. Year of plantations;
3. Practice of cultivation like seed and seedling collection and production procedures, cultivation system, technique of management of orchards and source of fund;
4. Year wise data on plantation and maintenance cost;
5. Year wise data on production of oranges and price receipt;
6. Selling and marketing process of oranges by the orange growers;
7. Pre-harvesting management process and post harvest management techniques used etc.

According to the information of the orange growers, different relevant data were collected from the contractors and intermediaries who buy the major orange orchards from the growers. As per information received from the sample orange growers different relevant data of pre-harvest and post harvest management, cost of marketing etc. were collected from the contractors and intermediary from Kamrup, Kamrup (M) and Tinsukia districts.
1.3. Analytical techniques

To acquire the knowledge of traditional cultivation technology, the secondary sources like different books and journals were explored. The traditional orange cultivation practices are found out from the field investigation and contract with the orange growers. Similarly to know the allocation of area, production and productivity the secondary source data were collected from the Department of Agriculture, Assam, National Horticultural Board, Indian Council of Agricultural Research, Umium, Meghalaya, Assam Agricultural University, Jorhat, Indian Institute of Entrepreneur, Guwahati, etc.

To assess the costs and returns, profitability and productive life of orange, the project evaluation method is used. Several techniques are available for evaluating the economic viability of an investment. Since initial investment in orange orchards is made once, the returns obtained from this investment spread over several years in future. The following are the widely used capital investment evaluation techniques:

a) Pay-back period (P),
b) Net present value (NPV),
c) Benefit-cost ratio (BCR),
d) Internal Rate of Return (IRR).

For evaluating the above, the following are specified:

\[ I = \text{Initial capital investment.} \]
\[ r = \text{Discount rate or cost of capital.} \]
\[ m = \text{Annual maintenance and operation cost.} \]
\[ n = \text{Number of years to depreciate the project.} \]
\[ D = \text{Annual gross benefits expected from the investment.} \]
\[ E = \text{Annual net benefits, after maintenance and operation costs, expected from investment.} \]
\[ B = \text{Total present value of the gross benefits.} \]
\[ C = \text{Total present value of the project costs.} \]

In algebraic form, B and C are expressed as follows:
\[ B = \frac{A_1}{(1+r)} + \frac{A_2}{(1+r)^2} + \frac{A_3}{(1+r)^3} + \ldots + \frac{A_n}{(1+r)^n} \]

\[ C = \frac{M_1}{(1+r)} + \frac{M_2}{(1+r)^2} + \frac{M_3}{(1+r)^3} + \ldots + \frac{M_n}{(1+r)^n} \]

1.3.1. Pay-back Period (P)

The payback period of an investment project tells us the number of years required to recover our initial cash investment. It is the ratio of the initial fixed investment over the annual cash inflows for the recovery period. It is the period for an investment to generate sufficient incremental cash to recover its capital outlay in full i.e.

\[ P = \frac{I}{E} \]

Symbolically, the payback period (P), where P is the lowest value of t (time) for which the following inequality holds

\[ \sum_{t=0}^{p} C_t < \sum_{t=0}^{p} R_t \]

Where, \( R_t \) = Return in period t
\( C_t \) = Cost in period t

Given the expected life of the project, the shorter the payback period the greater is the profitability.

1.3.3. Net Present Value (NPV): The net present value of an investment is the discounted value of all cash inflows and net of all cash outflows of the project during its life time. The calculation of net present value of an investment involves four steps:
First : to determine appropriate discount rate (r) or cost of capital;
Second: to compute the present value of total cash outlays (i.e. initial cost plus annual maintenance and operating costs) required by the project.
Third : to compute the present value of the additional cash inflows (i.e. gross
benefits) according to the project.

Fourth: the total present value of the capital outlay, as determined in the second step is subtracted from the total present value of the cash inflows as determined in the third step and the difference is known as the net present value of the investment; i.e.

$$NPV = \sum_{t=0}^{T} \frac{R_t - C_t}{(1+r)^t}$$

$r =$Discount rate.

$T =$Project life.

An initial investment would be justifiable, if the amount required to be invested is less than the net present value. In cases, where the initial investment themselves are considered along with the cost, the investment would be sound, so long as present value is positive.

### 1.3.4. Benefit Cost Ratio

The benefit cost ratio or profitability index gives the returns per rupee invested during the entire productive life period. The returns accruing out of the project and the capital invested at different periods of time during the project and the capital investment at different periods of time during the project has been discounted.

It is simply a ratio between the sum of discounted benefits and the discounted cost of the project.

$$BCR = \frac{\sum_{t=0}^{P} \frac{R_t}{(1+r)^t}}{\sum_{t=0}^{P} \frac{C_t}{(1+r)^t}}$$

The investment could be considered justifiable, if the above ratio is more than one.

### 1.3.5. Internal Rate of Return (IRR)

This is otherwise known as the discounted cash flow rate of return. IRR is that rate at which the discounted cash flows are equal to the investment outlay. In other word IRR is that rate which makes the present value of benefits equal to the present value of costs or reduces the net present value to zero.
Net present Value at the Lower discount rate

\[
\text{Net present Value at the Lower discount rate} = \frac{\text{Lower discount rate} + \text{Difference between the two discount rates} \times \frac{\text{Absolute difference between the net present values at the two discount rates}}{\text{Absolute difference between the net present values at the two discount rates}}}{\text{Absolute difference between the net present values at the two discount rates}}
\]

Singh (1988:179) remarks if a project guarantees an IRR that is greater than the cost of borrowing the capital, the project is economically viable. To know the marketing pattern of the orange by the orange growers, production cost and marketing costs are estimated. Generally the orange growers can sale the produced orange either harvesting themselves or selling to the contractors of middleman before harvesting.

**Layout of the Study**

The layout of the study is as follows:

- **Introduction**
- **Chapter I Review of literature**
- **Chapter II Part I Traditional Cultivation Practices of Orange**
  - Part II Allocation of Area, Production and Productivity of Oranges
- **Chapter III A few Socio-Economic Aspects of the Sample Orange Growers**
- **Chapter IV Economic Evaluation of Orange Cultivation**
- **Chapter V Orange Marketing of the Growers**
- **Chapter VI Harvesting, Pre-harvesting and Post-Harvesting Management**
- **Chapter VII Findings, Suggestions and Conclusion**

In the introductory chapter a brief historical background of the orange cultivation and the geographical environment of orange cultivation are briefly analyzed along with the objectives, methodology, chapter layout and limitation of the study were mentioned.

The first chapter tries to focuses the available literature on the subject.

In the second chapter, there are two parts. Part–I highlights the traditional cultivation practices of orange in the Brahmaputra valley while the Part –II explores the allocation of area, production and productivity of oranges not only in the sample areas but also in the important top ten countries along with India as a whole.
The third chapter focuses on a few aspects of the socio-economic status of the sample orange growers.

The fourth chapter highlights the important aspects of economic evaluation through the investment appraisal methods of orange cultivation of the sample orange growers of the Brahmaputra Valley.

The fifth chapter throws light on the orange marketing of the sample orange growers.

The sixth chapter deals with the harvesting, pre harvesting and post harvesting management of the orange cultivation practices.

The seventh chapter summarizes the findings and offers suggestions and conclusions for the improvements of the situation of orange cultivation and management in the state of Assam.

Limitation of the Study

The study has been conducted by selecting orange growers from three districts of the Brahmaputra valley. The selected districts are the most important districts so far as the quantity and quality of orange cultivation and production are concerned. The data are collected from the selected sample orange growers’ household as well as visiting the orange orchards. But it is mentioned here that the orange growers do not maintain the farm records like cost, expenditure, production, receipt of income, sale, land size etc. However, the data collected have been verified and compiled with reliable sources like the village heads, different local organizations like N.G.Os, and self help groups, agriculture development officers (ADOs), VLAEWs etc. The data received from the growers are also verified and compiled with the data received from the contractors and middleman. Although the selected sample is representative of all sizes of the orchards of both the upper and lower Brahmaputra valley, however, the result cannot be generalized for the State as a whole. The diverse caste and communities and their traditions and cultures result in differences in the cultivation practices in different places of the Brahmaputra valley. At the same time, the infrastructure like condition of road and communication, nearest markets, business organization, other processing units etc. may be different in accordance with different places.
The present study is expected to find out the traditional importance of the cultivation of orange as horticultural crop. Still, the modern technology has not been used in the orange cultivation in the Brahmaputra valley. It is important to observe that even that with the traditional cultivation system the cultivators earn income for their livelihood. Therefore, there is vast scope of investment in the field of orange cultivation. Even in the field of marketing and post harvest mechanism it is found that the traditional systems are dominated by the entire production and marketing process. Therefore this study enables to focus that the scope for improvement in the existing mechanism which can also influence in the field of horticulture.

As far as the demand of orange cultivation is concerned, both in fresh fruits market and in processing fruit market orange is considered one of the highly demandable item in both domestic as well as in international market. Therefore, this study is expected to fill an important gap and throw some new light into the problems of orange cultivation as well as the marketing and post harvest management aspects for policy implications in Assam.
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URL= <http://globaltrade.net/.../Brazil/Agriculture/>), accessed date 01-02-2010.


