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NEPAL AGRICULTURE RESEARCH COUNCIL

NATIONAL CITRUS RESEARCH PROGRAMME

PARIPATLE, DHANKUTA

2017

Nepal Agriculture Research Council (NARC)
National Citrus Research Programme (NCRP)
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FOREWORD

Citrus production has a great potential in Nepalese mid-hills for economic enhancement as well as nutritional supplement among the hill farmers. Although, the production of mandarin and sweet orange has been localized in mid-hills, acid lime production has been widened in hills and terai plains. The released acid lime varieties *viz.*, Sunkagati-1 and Sunkagati-2 are being popular and their saplings demand for commercial orchards have been ever increasing. National Citrus Research Programme (NCRP), Dhankuta has been working in coordination with other stakeholders to fulfill the demand of saplings, suitable varieties and technologies in the country.

From this year onwards, NCRP has got a new responsibility to carry out research activities on Sweet Orange (junar) under Prime Minister Agriculture Modernization Project (PMAMP) in Sindhuli and Ramechhap districts. NCRP has to coordinate with Project Implementation Unit of Super Zone Office separately established for sweet orange by Ministry of Agriculture Development under the PMAMP in the respective districts. Despite the chronic shortage of researchers and technical staff, NCRP has been working in full capacity to perform the required research and development activities as mandated by the nation. However, citrus development sector as in other sectors, essentially needs private partnership in each step from sapling production to fruit marketing and post harvest handling/processing as well. For instance, the private nursery business of citrus is growing well to meet the increasing demand of commercial farmers. NCRP is providing technical support at its level best to all kind of entrepreneurs through various means.

This annual report is a document of performed activities and achieved outcomes of this program during last fiscal year 2016-17 (2073/74). I am much thankful to all the researchers, technicians and technical helpers without whom, we could not have accomplished the approved research projects and could not meet the target of quality sapling production. At this moment, I would like to recall the contribution of all my predecessor coordinators who spent their valuable time and age in this isolated corner of hills. I am grateful to all the predecessor researchers who did hard work and establish research base for new generation researchers here in Paripatle, Dhankuta.

I hope that these research findings and other information presented in this report will be useful to all stakeholders including farmers, students and others who are interested in citrus production. I am grateful to NARC management team including the Executive Director, Dr. B.N. Mahto, Director (Crops and Horticulture), Dr. Y. P. Giri and Director

(Planning and Coordination), Dr. A.K. Gautam for their full support in implementation of the program. Last but not least, I would like to express my sincere thanks to Mr. Roshan Pakka, Scientist and Dr. Umesh Kumar Acharya, Senior Scientist for their conscientious work to prepare this annual report.

Hari Krishna Shrestha, PhD
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ACRONYMS

%	Percentage
@	at the rate
B.S.	Bikram Sambat
CFFT	Coordinated Farmers Field Trial
CIRAD	Agriculture Research for Development
Cm	Centimeter
CV	Coefficient of Variation
CVT	Coordinated Varietal Trial
DADO	District Agriculture Development Office
DFTQC	Department of Food Technology and Quality Control
DGR	Dry Ginger Recovery
Ento.	Entomology
et. al.	et alia
etc.	et cetera
FAO	Food and Agriculture Organization
FY	Fiscal Year
FYM	Farm yard manure
G	Gram
Ha	Hectare
Hort.	Horticulture
i.e.	that is
IAAS	Institute of Agriculture and Animal Science
ICAR	Indian Council of Agriculture Research
ICIMOD	International Centre for Integrated Mountain Development
INRA	French National Institute for Agriculture Research
JICA	Japan International Cooperation Agency
K	Potassium
Kg	Kilogram
LSD	Least Significant Different
Lt	Liter
m asl	meter above sea level
Ml	Milliliter
Mm	Millimeter
MoAD	Ministry of Agriculture Development
Mt	Metric ton
N	Nitrogen

NARC	Nepal Agricultural Research Council
NCRP	National Citrus Research Program
NGRP	National Ginger Research Program
NPR	Nepalese Rupee
NS	Non-significant
^{o}	Degree
P	Phosphorus
Patho.	Pathology
p^{H}	Potential of Hydrogen
PMAMP	Prime Minister Agriculture Modernization Project
RARS	Regional Agricultural Research Station
RATWG	Regional Agricultural Technical Working Group
RCBD	Completely Randomized Block Design
T	Ton
TA	Titratable Acid
TPR	Turmeric Powder Recovery
TSS	Total Soluble Solid
var.	Variety
viz.	Videlicet
Wt	Weight

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सुन्तलाजात फलफूल उत्पादन नेपाली कृषकहरुको रोजगारी र आर्थिक स्तर वृद्धिको लागि उच्च सम्भावना भएको क्षेत्र हो । राष्ट्रिय साथै अन्तराष्ट्रिय बजारको बढ्दो मागले गर्दा सुन्तलाजात फलफूल उच्च मुल्यको वस्तुको रुपमा चिनिन्छ । तसर्थ, सुन्तलाजात फलफूल उत्पादन र विकासको कार्यलाई नेपाल सरकारले उच्च प्राथमिकतामा राखेको छ । तथापि, विभिन्न किरा, रोग, माटोमा पोषणतत्वको कमी, चिस्यानको कमी, सिमित जातको उपलब्धता, स्वस्थ बिरुवाको न्यून उपलब्धता आदि समस्याले गर्दा यो फलफूलको उत्पादकत्व र गुणस्तरमा ह्रास चुनौतिको रुपमा देखा परेका छन् । यस अवस्थामा राष्ट्रिय सुन्तलाजात अनुसन्धान कार्यक्रमले उपयुक्त प्रविधि विकास गर्ने राष्ट्रिय जिम्मेवारीका साथ अनुसन्धान कार्यक्रम संचालन गर्दै आएको छ । गत आ. व. २०७३/७४ (२०१६/१७) मा यस अनुसन्धान कार्यक्रमले आठ वटा अनुसन्धान आयोजना अन्तर्गत ४३ वटा क्रियाकलापहरु सम्पन्न गरेको थियो । खासगरी यी अनुसन्धान आयोजनाहरुले जातीय अनुसन्धान, नर्सरी व्यवस्थापन, उत्पादनोपरान्तो भण्डारण, सुन्तलाजात बगैंचाको दिगो व्यवस्थापन, सुन्तलामा लाग्ने ह्रास रोग र औंसा किरा (फ्रुट फ्लाई) को व्यवस्थापन समेटेको थियो । अधिकांश क्रियाकलापहरु निरन्तर संचालित छन् । ती मध्ये केहि क्रियाकलापहरुले महत्वपूर्ण परिणाम सहित निष्कर्ष निकालेको छ; जसको सारांश तल उल्लेखित गरिएको छ ।

- स्थानीय र विदेशबाट संकलन गरिएका कुल १२० वटा विभिन्न सुन्तलाजातका जर्मप्लाज्महरु यस कार्यक्रम (पारीपाल्ले, धनकुटा) मा संरक्षण गरी हुर्काइएका छन् । यी संरक्षित जर्मप्लाज्ममा सुन्तला, जुनार, कागती, ज्यामिरे, ग्रेपफ्रुट, ट्याङ्गोर, ट्याङ्जेलो र विभिन्न रुटस्टक सामग्रीहरु पर्दछन् । विभिन्न जातहरुको फूल फुल्ने, फल लाग्ने, फलको गुण र बाहिरी गुणहरुमा प्रष्ट रुपमा विविधता पाईएको छ । सर्वोकृष्ट जात छनोटको लागि आर्थिक हिसाबले थप अध्ययन गर्न जरुरी देखिन्छ ।
- सुन्तला, जुनार, कागती र ट्याङ्गोरका प्रचलित जातहरुले कम उत्पादन र छोटो उत्पादन अवधिको परिणाम देखाएको छ । राष्ट्रिय सुन्तलाजात अनुसन्धान कार्यक्रमले विगत आ.ब. २०६३/६४ देखि आयातित जातहरुको साथै राम्रा स्थानिय जातहरु भित्राउनुको साथै तिनमा परिक्षण गर्दै आएको छ । सुन्तलाको जातीय परिक्षणको प्रारम्भिक नतिजा अनुसार आयातित जातहरु जस्तै मियागावासे, ओकित्सुवासे, सत्सुमा मिनो, सत्सुमा ओकित्सु चाँडै पाक्ने र राम्रो उत्पादन दिने जातको रुपमा पाईएको छ । दुई वटा सुन्तलाका जातहरु खोकु लोकल र ओकित्सुवासेलाई विगत आ. व. २०६०/६१ देखि २०७३/७४ सम्म परिक्षणको आधारमा फलको उत्पादन र राम्रा गुणको कारणले उन्मोचन गर्ने प्रक्रियामा राखिएको छ ।
- जुनारको वासिंगटन नाभेल र भ्यालेन्सिया लेट अन्य जात भन्दा फलको उत्पादन र अन्य उत्पादन सम्बन्धि गुणले गर्दा राम्रो पाईएको छ । यी जातहरु बेमौसमी उत्पादनको लागि

सुहाँउँदो पनि छ । अन्य जातहरुमा माल्टा ब्लड रेड, लेन लेट, सुक्कारी र धनकुटा लोकल फल उत्पादनको दृष्टिले राम्रा देखिएका छन् ।

- त्यस्तैगरि, ट्याङ्गोरको इलेन्डेल, ट्याङ्जेलोको मिन्नेला, ग्रेपफ्रुटको पिंक रुबी र हेन्डरसन जातहरु उत्पादन र उत्पादन सम्बन्धि अन्य गुणहरुले गर्दा राम्रा पाईएका छन् ।
- सुन्तला खेती व्यवसायको लागि सुन्तलामा लाग्ने ह्रास व्यवस्थापन अति नै महत्वपूर्ण हुन्छ । यो समस्याको सम्बोधन गर्न राष्ट्रिय सुन्तलाजात अनुसन्धान कार्यक्रमले एकिकृत खाद्यतत्व व्यवस्थापन, रोग किरा व्यवस्थापन र दिगो बगैंचा व्यवस्थापनको लागि काम गरेको छ । सुन्तलाजातमा फाइटोप्थोरा र फ्युजारियमका कारणले लाग्ने जरा कुहिने रोग व्यवस्थापनको लागि विभिन्न जैविक तथा ढुसिनाशक विषादीहरुको प्रभावकारिताबारे अध्ययन गरेको थियो । ट्राइकोडर्मा भिरिडी (*Trichoderma viride*) र स्युडोमोनास फ्लुरोसेन्स (*Pseudomonsas fluroscens*) जस्ता जैविक नियन्त्रणका जीवाणु साथै कार्बेन्डाजिम र कपरअक्सिक्लोराईड जस्ता ढुसीनाशक विषादी र बोर्डेक्स मिक्स्चरले बोटमा ड्रेन्चिङ्ग गर्दा जरा कुहिने रोगको राम्रो नियन्त्रण भएको पाईयो ।
- सुन्तलामा पोष्ट हार्भेस्ट सम्बन्धि अध्ययनको नतिजा निकाल्न आगामी बर्षमा परिक्षण विधिमा परिवर्तन गर्न आवश्यक देखिएको छ ।
- कागतीको रुटस्टक सम्बन्धि परिक्षणमा भोगटे, सेती ज्यामिरे र रंगपुर लाइम जस्ता तीन वटा रुटस्टकहरुले उत्कृष्ट नतिजा दिएको छ ।
- कलमी बिरुवाको वृद्धि र विकासको लागि आवश्यक माटोको मिश्रण सम्बन्धि अध्ययनमा सतहको माटो, बालुवा र गोबर मलको १:१:१ अर्थात बराबर मात्रामा र सतहको माटो, बालुवा र भर्मीकम्पोस्टको १:१:१ अर्थात बराबर मात्रामा प्रयोग गर्दा उत्कृष्ट नतिजा दिएको छ ।
- बीउको अधिकतम उमारशक्तिको लागि ट्राइफोलियट (तीनपाते) सुन्तला फलको उपयुक्त अवस्थाको अध्ययनमा आधा पाकेको र पूर्ण रुपमा पाकेको फलबाट निकालिएको बीउमा अधिकतम उमारशक्ति पाईयो ।
- विभिन्न वातावरण र विभिन्न बीउ रोप्ने समयमा ट्राइफोलियट सुन्तलाको उमारशक्ति परिक्षण गर्दा भाद्र महिनाको तेश्रो हप्तामा दैलेख बिधि र भाद्र महिनाको तेश्रो हप्तादेखि असोजको पहिलो हप्तासम्म एन.सि.आर.पि. विधिको प्लाष्टिक टनेलमा अधिकतम बीउ उमारशक्ति पाईयो ।
- सुन्तला र कागतीको माउ बोटबाट निकालिएको सायन श्रोत सामग्रीको रुपमा स्थानिय नर्सरी व्यवसायीहरुलाई उपलब्ध गराईएको थियो । त्यस्तैगरी, सुन्तलाको खोकु लोकल र ओकित्सुवासे, कागतीको दुई जातहरु सुनकागती-१ र सुनकागती-२ को कलमी बिरुवाहरु विभिन्न स्थानका कृषकहरुलाई उपलब्ध गराईएको थियो ।

- गत आ. व. २०७३/७४ मा कृषकहरु र अन्य सरोकारवालाहरु गरि जम्मा १५५० जनालाई प्राविधिक सल्लाहका साथै संचालित अध्ययन अनुसन्धान कार्यक्रम र नयाँ प्रविधि बारे जानकारी गराईएको थियो ।
- गत आ. व. २०७३/७४ मा सुन्तलाको ४९९, जुनारको ४२८, कागतीको ७,४२६, मुन्तलाको ३० र गुलाफका ६१ गरि जम्मा ८,४४४ गोटा कलमी बिरुवा कृषकहरुलाई बिक्रि वितरण गरेको थियो ।
- गत आ. व. २०७३/७४ मा यस कार्यक्रमलाई कूल वार्षिक बजेट २.७४० करोड विनियोजन भएको थियो जसमा १.०४५ करोड अनुसन्धान कार्यक्रमलाई विनियोजन गरिएको थियो ।

Executive Summary

Citrus has been as a high prospect sector for raising the economic standard and employment to the farmers of Nepal. This sector has been recognized as the high value commodity following the increasing demand for domestic as well as international market. Thus, the government of Nepal has kept citrus sector under high priority for its growth and development in the country. However, lower productivity and low quality due to increasing problem of various insects, diseases, nutritional deficiency, moisture stress, limited variety and inadequate sources for healthy planting materials are the main challenges for citrus industry. In these contexts, National Citrus Research Program (NCRP) with the national mandate of developing appropriate technologies has been conducting research programs for promoting the citrus industry in Nepal. During the fiscal year 2073/74 (2016/17), a total of 43 activities under 8 research projects were accomplished by NCRP, Dhankuta. Particularly, these research projects comprised of varietal research, nursery management, post-harvest storage, sustainable management of citrus orchard, management of citrus decline and fruit fly. Most of activities are under continuation, while some of them were concluded with worthwhile outputs that are summarized below.

- The total of 120 different citrus germplasms have been collected from local and exotic sources during different periods which are conserved and maintained in field gene bank of National Citrus Research Program, Dhankuta. These conserved germplasm includes mandarin orange, sweet orange, acid lime, lemon, grapefruit, tangor, tangelo and different rootstock species. A distinct variation with respect to flowering, fruiting behavior, fruit traits and morphological characteristics has been observed. Further selection is necessary to screen the best variety based on economic characters.
- As the existing cultivars of mandarin, sweet orange, acid lime and tangor are resulting poor yield and short production period, the exotic cultivars and elite local cultivars have been introduced, and they have been being evaluated by NCRP since 2063/64. The preliminary performances of varietal evaluation of mandarin revealed some exotic genotypes such as Miyagawase, Okitsuwase, Satsuma Mino, Satsuma okitsu resulted in promisingly early for crop maturity and fruit yield. Two genotypes of mandarin *viz.*, Khoku local and Okitsuwase are in process of being proposed for variety released based on their performance for yield and yield attributes that were evaluated from 2060/61 to 2073/74.
- Washington Navel and Valencia Late, varieties of sweet orange have been giving better results in terms of yield and yield attributing characteristics than those of other varieties. These genotypes were noted suitable for off season production. Similarly,

other genotypes *viz.*, Malta blood red, Lane late, Succari and Dhankuta local have shown good fruit yield potential.

- Similarly, Ellendale, a variety of tangor; Minneola, a variety of tangelo; Pink ruby and Henderson, varieties of grapefruit have shown their good performance in terms of yield and yield contributing characteristics.
- Citrus decline management is the crucial aspect of citrus industry in Nepal. To address this problem, NCRP has been working on integrated plant nutrient management, pest & disease management, and sustainable orchard management. The study on efficacy of different bio-control agents and fungicides for management of citrus root rot caused by Phytophthora and Fusarium was carried out. The study resulted that drenching with bio-control agents like *Trichoderma viride* and *Pseudomonas fluroscens*; fungicides like carbendazim, copperoxychloride and Bordeaux mixture gave good result in controlling the disease.
- The result from post-harvest study showed that there is a further need in modification in treatment given.
- The result of rootstock trial for acid lime showed that three rootstocks *viz.*, Pumelo, Seti jyamire and Rangpur lime showed better performance in different morphological traits.
- The study on different soil mixture on growth and development of grafted saplings resulted that soil mixture of surface soil, sand and FYM (1:1:1) and the mixture of surface soil, sand and vermicompost (1:1:1) were found better.
- The study on appropriate stage of trifoliate orange for maximum seed germination showed that seeds obtained from half yellow and full ripe fruits resulted maximum seed germination.
- The study on seed germination of trifoliate orange under different raising environmental condition in relation to different sowing date resulted that seeds sown under Dailekh method in 3rd week of Bhadra, and NCRP method in 3rd week of Bhadra to 1st week of Asoj resulted maximum seed germination.
- The scion sources from the mother plant of mandarin and acid lime varieties were provided to the nearby nursery entrepreneurs. Likewise, grafted saplings of Khoku local mandarin, Okitsuwase, acid lime varieties *viz.* Sunkagati-1 and Sunkagati-2 were provided to the farmers in different locations.
- During the fiscal year 2073/74, technical counseling was given to 1,550 farmers and other stakeholders regarding the research programs and technologies for citrus sector.
- In the fiscal year 2073/74, a total of 8,444 grafted saplings constituting of 499 mandarin, 428 sweet orange, 7426 acid lime, 30 kumquat and 61 roses were made available to farmers.
- The total annual budget approved for fiscal year 2073/74 program was Rs.27.40 million, while operational budget consisted of Rs.10.45 million to carry out research projects.

1. PROGRAMME CONTEXT

Citrus fruits in Nepal occupy an important subsector of agriculture following the congenial geography and climate. In the light of growing awareness among young generation towards commercial agro-enterprises, it might become an economically viable enterprise for them, contributing to national economy.

Nepal is noted for the production of quality mandarin and sweet orange. The sub-tropical climates of mid hill districts ranging from 800 to 1,400 masl altitude along with favorable edaphic condition across the country are considered quite suitable for growing citrus fruits. Moreover, the pocket areas with deep sandy loam soil and soil pH range of 5.0 to 6.5 are most suitable for the cultivation of citrus. In recent years, citrus is grown commercially in 50 hill and 16 terai districts of Nepal.

The statistics shows that the area and production under citrus fruit crops are increasing during last 14 years. The current area is recorded to be 40,554 ha producing 2,18,447 metric tons with productivity of 8.82 mt/ha (Table.1), which is very low compared to the most citrus growing countries in the world. The productivity is in declining trend and some studies revealed that such productivity deteriorated situation is mostly linked to poor orchard management and declining soil fertility in Nepal. Thus, there has been a huge scope of increasing the production and productivity through the use of improved technologies.

Table 1: Area, production and productivity of citrus fruits during 2003/04 to 2015/16

Year	Total area (ha)	Productive area (ha)	Production (mt)	Productivity (mt/ha)
2003/04	24,799	13,931	1,48,010	10.62
2004/05	25,910	14,606	1,56,956	10.75
2005/06	26,681	15,206	1,64,075	10.79
2006/07	27,980	15,832	1,71,875	10.86
2007/08	30,790	19,915	2,26,404	11.37
2008/09	32,322	22,482	2,53,766	11.29
2009/10	33,898	22,903	2,59,191	11.30
2010/11	35,578	23,609	2,63,710	11.20
2011/12	37,565	24,089	2,40,793	10.00
2012/13	36,975	23,645	2,16,188	9.14
2013/14	38,988	25,497	2,24,357	8.80
2014/15	39,035	25,261	2,22,790	8.82
2015/16	40,554	24,854	2,18,447	8.82

Source: MoAD, Nepal, 2017

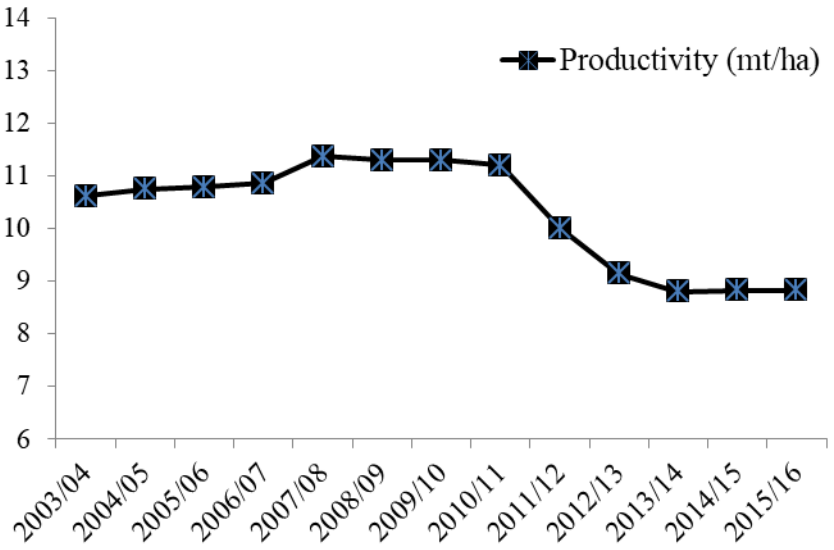

Figure 1: Productivity of citrus crops during different period

Table 2 highlights the total area, productive area, production and productivity of major citrus fruit crops such as mandarin orange, sweet orange, acid lime, lemon and other citrus fruit crops. In terms of area, productive area and production; mandarin has acquired the first position with 26,282 ha, 16,248 ha, 1,46,690 mt respectively, but sweet orange has the highest productivity (9.7 mt/ha). On the other hand, lemon fruit acquired the lowest area (837 ha), productive area (595 ha), and production (4,941 mt). The lowest productivity of 7.0 mt/ha was recorded with acid lime.

Table 2: Total area, productive area, production and productivity of major citrus fruits in Nepal (2015/16)

Major citrus fruits	Total area (ha)	Productive area (ha)	Total production (mt)	Productivity (mt/ha)
Mandarin orange	26,282 (64.81)	16,248	146,690	9
Sweet orange	5,131 (12.65)	3,443	33,558	9.7
Acid lime	7,296 (17.99)	3,858	27,017	7
Lemon	837 (2.06)	595	4,941	8.3
Other citrus species	1,008 (2.49)	741	6,242	7.1
Grand Total	40,554	24,885	218,448	8.79

Source: MoAD, Nepal, 2017

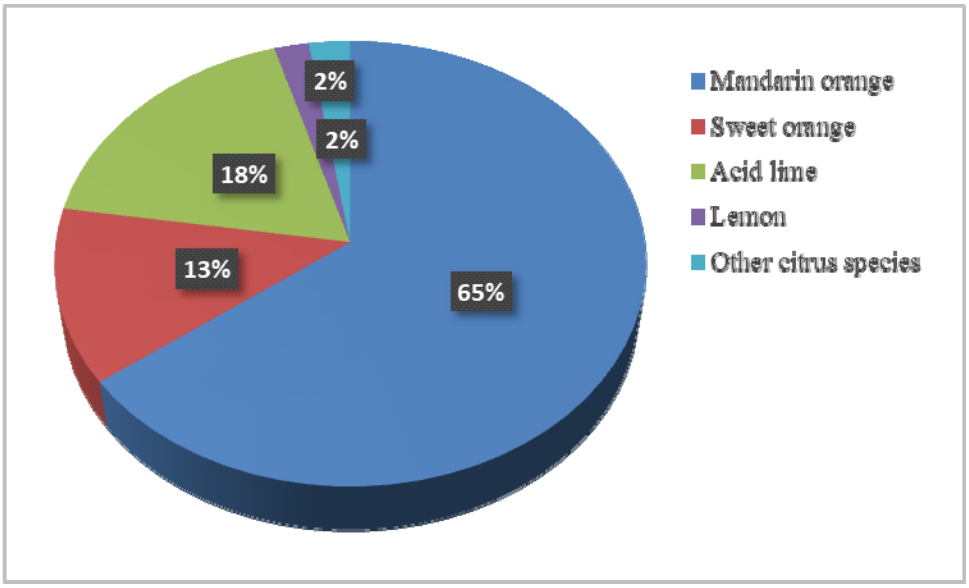

Figure 2: Total area (in percentage) of major citrus fruits in Nepal during 2015/16

The result shown in above pie-chart reveals that mandarin orange covers the maximum production area among citrus fruit. Mandarin orange covers 65.0% area among the citrus cultivated area. Similarly, acid lime, sweet orange, lemon and other citrus covers 18.0%, 13.0%, 2.0% and 2.0% respectively.

Table 3 shows the total orchard area, productive area, production and productivity of four groups of citrus based on development region of the country. In terms of total cultivated area, productive area and production of citrus crops, regardless of respective group, western region has occupied the first position with 13,213 ha, 8,352 ha and 79,509 mt respectively, but central region has stood the first position for productivity (8.90 mt/ha) followed by western region with 7.96 mt/ha and far-western region with 7.62 mt/ha. Although, area, productive area and production of mandarin orange is highest in western region with 10,094 ha, 6,571 ha and 65,221 mt; productivity is noted to be the highest in central region (9.7 mt /ha) followed by western region (9.1 mt/ha) and western eastern (8.7 mt/ha) while the lowest productivity of mandarin is in mid-western region (7.8 mt/ha). As for sweet orange, central region has had considerably highest area (2,275 ha), productive area (1,431 ha), production (16,572 mt) and productivity (10.7 mt/ha) whereas mid-western region showed the lowest productive area (310 ha) and production (3,425 ha). The lowest productivity was found in Eastern region (7.4 mt/ha). Eastern region showed considerably the maximum acid lime area (2,706 ha), productive area (1,481 ha) and production (96,428 mt). However, highest productivity for lemon was recorded from central region (7.7 mt/ha). Far-western region

reflected minimally lowest for acid lime in respect of area (584 ha), productive area (371 ha) and production (2,628 mt). Mid-western region had lowest productivity (6.9 mt/ha). In regards with lemon fruit crop, its' total area (328 ha), productive area (197 ha), production (1,578 mt) and productivity (7.9 mt/ha) are recorded to be highest in eastern region. In contrast, the lowest production area, productive area and production was found in western region with 92 ha, 58 ha and 459 mt respectively. As for other citrus fruit crop, cropped area (458 ha), productive area (364 ha), production (3258 mt) and productivity (7.7 mt/ha) have been noted the highest in western region. The lowest production was noted from mid-western region (74 mt), whereas the lowest productivity (6.8 mt/ha) was recorded from central and far-western region.

Table 3: Total area, total productive area, total production and productivity of different citrus species in different regions of Nepal (2015/16)

Major Citrus species	Regions	Area (ha)	Productive area (ha)	Production (mt)	Productivity (mt/ha)
Mandarin orange	Eastern	5,439	3,756	35,574	8.7
Sweet Orange	"	748	581	4,310	7.4
Acid Lime	"	2,706	1,481	9,628	6.1
Lemon	"	328	197	1,578	7.9
Other Citrus species	"	222	143	1,213	6.8
Sub-total		**9,443**	**6,158**	**52,303**	**7.38**
Mandarin orange	Central	3,768	2,726	28,506	9.7
Sweet Orange	"	2,275	1,431	16,572	10.7
Acid Lime	"	1,529	704	5,478	7.7
Lemon	"	134	115	1151	9.4
Other Citrus species	"	224	184	1,374	7
Sub-total		**7,930**	**5,160**	**53,081**	**8.9**
Mandarin orange	Western	10,094	6,571	65,221	9.1
Sweet Orange	"	1032	673	5,656	7.9
Acid Lime	"	1,537	686	4,920	7.5
Lemon	"	92	58	459	7.6
Other Citrus species	"	458	364	3,253	7.7
Sub-total		**13,213**	**8,352**	**79,509**	**7.96**
Mandarin orange	Mid-western	4,973	2,401	17,999	7.8
Sweet Orange	"	552	310	2,534	8
Acid Lime	"	1067	667	4,510	6.6
Lemon	"	145	116	837	6.9
Other Citrus species	"	25	12	74	7.3
Sub-total		**6,762**	**3,506**	**25,954**	**7.32**
Mandarin orange	Far-western	1,200	820	6,912.00	8.3
Sweet Orange	"	528	440	4,487	9.3
Acid Lime	"	457	326	2,213	5.7
Lemon	"	139	111	920	8
Other Citrus species	"	80	40	328	6.8
Sub-total		**2,404**	**1,737**	**14,860**	**7.62**

Source: MoAD, Nepal, 2017

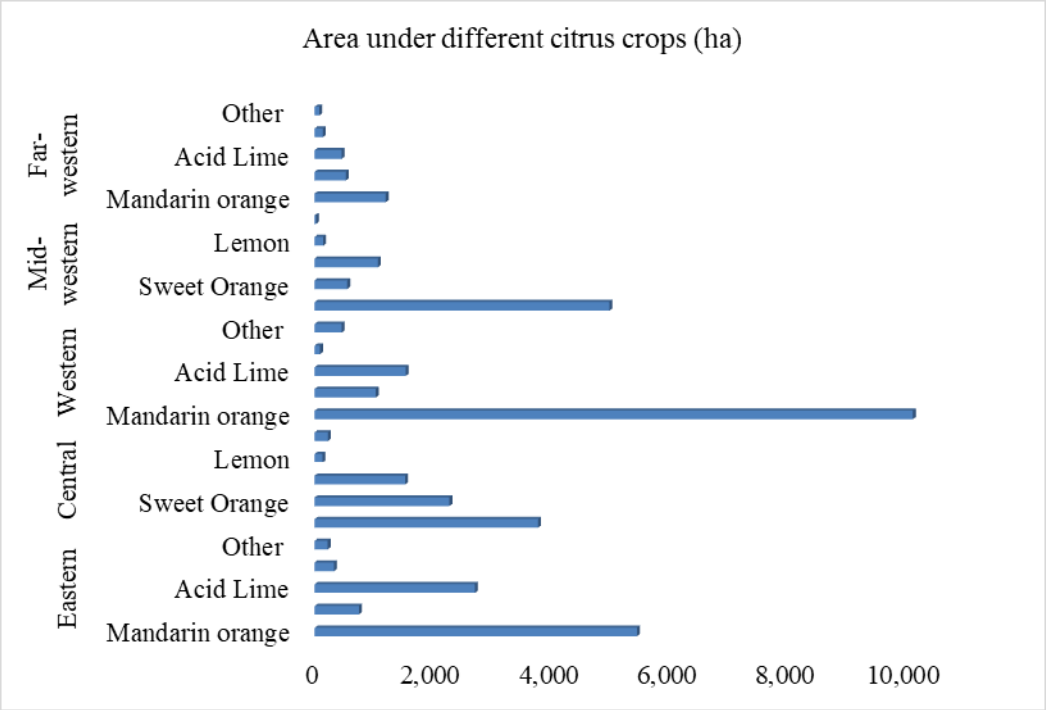

Figure 3: Total areas of major citrus fruits in different regions of Nepal in 2015/16

The result presented in bar diagram reveals the five different regions on Y-axis and area (ha) on X-axis. There is the highest area for mandarin orange production among different citrus fruits in each of the regions in the country. Of all regions, western region has possessed the largest area of citrus (13,213 ha). Western region has highest area for mandarin orange cultivation with the total area of 10,094 ha. The central region has largest area for sweet orange production (2,275 ha) as comparing against all the regions. In respect of area for acid lime and lemon, eastern region stands first with area of 2,706 ha and 328 ha respectively.

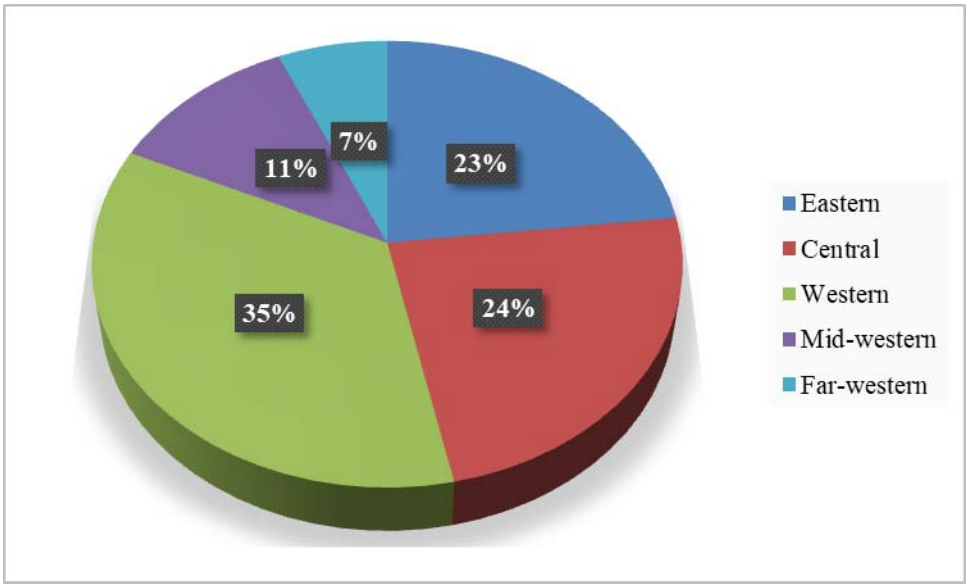

Figure 4: Total production of citrus in five development regions during 2015/16

The pie-chart shows the status of citrus fruit production of five regions of Nepal. Out of total citrus production; i.e. 2,2,705 mt, western region contributes maximum (35%) citrus production with total production of 79,509 mt followed by central region (53,081 mt) and eastern region (52,303 mt). Citrus crops share about 25.96% of the total fruit area in Nepal. The government of Nepal has recognized mandarin and sweet orange as the potential export commodities, taking place of an initiative for exporting sweet orange in Tibet. Nevertheless, citrus industry is still facing several problems, some important are: traditional practices for crop management, short production season of existing varieties, declined soil fertility and water resources, citrus greening and fruit fly, poor quality and small production scale, poor infrastructures and legal and institutional mechanism for marketing and lack of entrepreneurship for this crop.

The domestic production meets only fewer percentage of national demand during main season that fresh as well as processed citrus worth hundred million rupees is being imported every year. Hence, Nepal holds an important potential area for commercialization of citrus sector towards import substitution and export promotion.

Majority of farmers are small scale producers characterized by small land holdings with low investing and risk bearing capacity. This is the major reason of poor crop management that requires high level of external inputs; high skills and good crop management knowledge, which are not within the capacity of most farmers. There is

serious short coming on crop husbandry practices in most citrus orchards like manuring, training/pruning, disease and pest control among others. As a result, many orchards are in declining states.

Mostly farmers have no access to the certified planting materials free of diseases including Phytophthora root rot, citrus greening, canker and tristeza virus. Similarly, there is a lack of varietal diversity for extending the production season at farmer's field. Therefore, the production of existing varieties is limited to very short period during normal season. As a result, Nepal imports mandarin, sweet orange and acid lime worth more than hundred million annually. Poor fruit quality due to insect pests and diseases as well as poor orchard management, and physical damage during harvest and transport are some the important aspects to be considered for the export business in the future.

These contexts bring about to many areas of research and development to be carried out, ranging from variety improvement, tree health management, integrated soil management, plant protection, postharvest handling, processing, and marketing. Eventually the sector could be transformed into commercial and export industry producing quality fruits in sizeable volume.

2. INTRODUCTION

2.1 Background

Citrus is an important subsector of Horticulture for raising economy of Nepalese farmers. Because of appropriate geography and climate, citrus is grown throughout the mid-hills (800-1400 masl) from east to west across the country. Moreover, the government of Nepal has recognized it as potential crop for income and employment generation through import substitution and export promotion.

Taking the importance of this sector into account, government of Nepal had initially established Citrus Research Station, Paripatle in 1961 (2018 B.S.). Then, it has been recognized as National Citrus Research Programme (NCRP) in 2000 (2057 B.S) under NARC with the national mandate of conducting citrus research and studies and producing & distributing healthy saplings of various citrus species. Located at Dhankuta-13, Paripatle of Dhankuta district between 27°1' north latitude and 87°18’ east longitudes with the elevation of 900-1,390 masl, the research farm occupies 20 ha area with south-east aspect. It is situated at about 8 kilometers in north-west direction from Dhankuta district headquarters in the far-eastern region of Nepal.

The research farm extending on 20 ha of terrace land, most of area is occupied by production orchard of major citrus species including mandarin, sweet orange and acid lime. A field gene bank has been maintained for conserving exotic as well as local citrus

genotypes. Similarly, on-station varietal research plots occupy larger portion of the farm. The NCRP has seven screen houses, where mother plants of promising varieties of mandarin, sweet orange, kinnow and acid lime are maintained. It has a separate nursery block extending on three hectare, where research activities related with plant propagation and nursery production are carried out. Other infrastructures include tissue culture lab, agronomy lab and cellar store, irrigation canal and ponds. Under these narrow facilities including limited human resources, the programme has given thrust on variety improvement and selection, crop husbandry, citrus decline management, nursery management and plant propagation, citrus pest management, tissue culture for nursery production, high density planting and postharvest studies.

2.2 Goal

Contribute to increase productivity and quality production of citrus fruit crops through use of modern technologies.

2.3 Purpose

Increase economy and living standard of farmers through commercialization of citrus sector by technology advancement.

2.4 Objectives

1. To conduct research on variety, husbandry management, postharvest, disease/pest control, nursery, tissue culture and genetic resource conservation and utilization
2. To coordinate with various research and development line agencies for collaborative citrus research and development programs
3. To establish linkage with national and international citrus research organizations
4. To prioritize research areas in the country
5. To document and maintain information on citrus research and development
6. To provide technical supports and services to citrus stakeholders

2.5 Strategies

1. Conduct participatory, holistic and systematic research and studies on citrus fruit crops
2. Prioritize research areas and policy formulation based on problems and demands in citrus sector
3. Variety improvement and selection for extended harvesting season
4. Enhancing production and productivity by generating technologies
5. In-vitro technology for healthy propagation
6. Conservation and improvement of citrus genetic resources

7. Technologies advancement on citrus-based farming system
8. Marketing and export promotion of citrus industry
9. Ensuring effective dissemination and adoption of developed technologies
10. Coordination and collaboration with line agencies including farmers' communities

2.6 Responsibilities

1. Identify problems and needs of citrus sector for setting up the research areas
2. Develop appropriate technologies on different aspects of citrus fruit crops
3. Genetic resources conservation and utilization
4. Mother plant maintenance and nursery plant production
5. Out-scaling of technologies for wider impact
6. Coordinate with other national and international organizations for collaborative research and studies
7. Publications and documentation
8. Provide technical and consultancy services to the clients

2.7 Prioritized Research for upcoming years

- Integrated approach to combat citrus decline
- Postharvest processing and value addition
- Marketing and export business
- Cost effective and eco-friendly production technologies
- Integrated nutrient management
- Breeding new varieties for extended harvest period
- Biological pest and disease control
- Water use efficiency
- *In-vitro* technology for healthy propagation
- Citrus based farming system
- Socio-economic studies

2.8 Infrastructure and resources

National Citrus Research Programme (NCRP), initially established in 1961 (2018 B.S.) as Citrus Research Station, is the commodity research programs under the Nepal Agricultural Research Council (NARC) since 2000 (2057 B.S) with mandate of technology generation on citrus fruit crops at national level. NCRP has 20 ha of farm area including forest and ditch areas.

The production block of mandarin and sweet orange comprising of Khoku local and Dhankuta local varieties respectively, occupy larger area of the farmland. There are five

separate blocks for varietal research of mandarin, sweet orange, acid lime, rootstock species and hybrid mandarin around the farm. Likewise a field gene-bank is maintained for in-situ conservation of citrus species. Furthermore, a block is also established for demonstrating the released acid lime varieties including other promising lines.

For nursery propagation and research, the farm has an isolated nursery segment expanding in two hectare area accommodating four screen houses (two iron-framed and two bamboo-made screen houses) and more than twenty nursery beds where mother-plants for various citrus species are planted. Similarly, there is well-equipped tissue culture laboratory including general laboratory-building and two glasshouses. Several irrigation ponds are set up across the farmland while one seven-hundred long pipe-fitted canal was established for irrigation.

2.9 Organization structure and human resource

NCRP is mainly constrained with a shortage of human resources for many years. Currently, the national mandated programme is working with a small team of human resource comprised of one senior scientist (Horticulture), one scientists, one technician and twelve support staffs including administrative and account staffs. Thus, it seems an urgent need to fulfill the vacant positions approved by the council. The detail of the working human resource in fiscal year 2072/73 is depicted in Annex 3.

3. RESEARCH HIGHLIGHTS

3.1 Varietal research

The existing commercial varieties of citrus species have low yield potential with short harvesting period in Nepal. A great genetic diversity exist among citrus specis across the country for the fruit characteristics. However, almost all varieties of mandarin, sweet orange and acid lime have the same harvesting period that the production of these species is limited to October to January. Therefore, appropriate varieties alternative to these varieties for expanding the production period are necessary in Nepal.

NCRP, Dhankuta has introduced several exotic varieties of mandarin, sweet orange and acid lime including elite local landraces in different periods. The performance of these genotypes has been studied for last few years in order to select and determine the appropriate varieties in different specific agro-climates.

3.1.1 Field Gene Bank

Collection and maintenance of citrus fruit genotypes is an important thrust of National Citrus Research Program. A total of 120 citrus genotypes have been collected from local and exotic sources during different periods since 2001. These are preserved at field gene

bank of NCRP, Paripatle, Dhankuta. These species includes mandarin, sweet orange, acid lime, grapefruit, lemon, tangor, tangelo, and rootstock species. The exotic genotypes were introduced mainly from India, Pakistan, France, Japan and Vietnam, while local genotypes were collected from different regions of Nepal. In 2004, 39 exotic citrus varieties including 16 mandarin, 6 sweet orange, 4 grapefruit, 3 tangor, 3 tangelo, and 7 rootstock varieties were introduced from France with the support of Prf. Joseph Bove of French National Institute for Agriculture Research (INRA), CIRAD. Similarly, three dwarf varieties of Unshiu mandarin were introduced from JICA, Japan in 2001. Likewise, promising 12 varieties of sweet orange were introduced from ICAR, India during 2006. Several varieties of sweet orange, grapefruit and acid lime were collected with the support of ICIMOD, Vietnam and IAAS, Rampur during different period. Similarly, 21 promising acid lime cultivars were collected from different districts and other local sources during different periods (Annex 1). These cultivars are to be screened based on fruit yield and fruiting characteristics. Preliminary characterizations of each variety were carried out and distinct variations with respect to fruiting behavior, fruit traits and morphological characteristics have been observed. Further selection is necessary to screen the best variety based on economic characters.

3.1.2 Varietal Evaluation

3.1.2.1 Mandarin orange

Mandarin (*Citrus reticulate* Blanco) is a high potential fruit crop in Nepal. It is widely grown throughout the mid-hills across the country. In Nepal, almost all mandarin varieties are of local origin that are specific to the location and vary each other. These varieties are characterized as declining yield potential and short production period within the same season. Therefore, mandarin production is confined to three to four months leading to shortage during other period of the year. A huge amount is being imported to meet the national demand during other period of the year.

Thus, NCRP has continued the study on the variety introduction and selection to determine the appropriate varieties instead of local varieties to expand the production period. In this line, variety selection and evaluation has been continued and 22 varieties introduced from abroad and local sources have been evaluated since 2063/64.

Physical characteristics of fruits of different genotypes of Mandarin

Table 4 reveals that all three fruit characteristics (fruit weight, fruit diameter and number of segments/fruit) were highly significant between genotypes.

Fruit weight:

Individual fruit weight differed significantly between test genotypes ranging between 61.44 gm and 166.60 gm with mean value of 117.15 gm. NCRP-95 produced the heaviest fruits (166.60 gm) followed by NCRP-81 (159.10 gm), NCRP-8 (150.90 gm), NCRP-98 (140.60 gm), and NCRP-89 (138.00 gm). NCRP-93 had the lightest fruit weight (61.44 gm). Other lighter fruits were observed in NCRP-94 (62.40 gm), NCRP-101 (79.09 gm), and NCRP-99 (80.84 gm) (table 4).

Fruit Diameter:

Fruit diameter was significantly different among genotypes and ranged between 41.67 cm and 68.72 cm with mean value of 57.72 cm. NCRP-95 had the highest fruit diameter (68.72 cm) followed by NCRP-8 (67.09 cm), NCRP-98 (64.27 cm), and NCRP-81 (63.93 cm) and so on. The least fruit diameter (41.67 cm) was observed in NCRP-94. NCRP-93 (46.28 cm), NCRP-101 (52.02 cm), NCRP-99 (53.65 cm) and so on. No definite correlation was observed between fruit weight and fruit diameter (table 4).

Number of Segments/fruit

The data in table 4 shows that the number of segment varied from 8.47 (NCRP-100) to 11.80 (NCRP-89) with significant differences between genotypes, the mean value being 10.24. The highest number of segments (11.80) was found in NCRP-89 followed by NCRP-81 (11.60), NCRP-95 (11.40) and NCRP-80 (11.33). The lowest number of segments/fruit (8.47) was observed in NCRP-100. Similarly, NCRP-101 (8.50), NCRP-98 (8.80), and NCRP-99 (8.83) had lower number of segments/fruit.

Table 4: Fruit physical parameters of mandarin genotypes at NCRP in 2016/17 (2073/74)

Genotypes	Fruit weight (gm)	Fruit diameter (mm)	No of segments/fruit
NCRP-1	123.80 abcd	57.48 cd	10.00 def
NCRP-5	128.50 abcd	58.63 cd	11.04 abc
NCRP-6	120.60 bcde	56.88 cd	11.22 abc
NCRP-8	150.90 ab	67.09 ab	10.47 cde
NCRP-10	99.34 cdef	56.04 cd	9.67 efg
NCRP-11	90.44 def	53.73 de	9.43 fgh
NCRP-80	124.10 abcd	57.54 dc	11.33 abc
NCRP-81	159.60 ab	63.93 abc	11.60 ab
NCRP-82	127.00 abcd	59.36 bcd	10.60 cde
NCRP-89	138.00 abc	59.78 bcd	11.80 a
NCRP-90	118.20 bcde	57.33 cd	10.40 cde
NCRP-92	119.60 bcde	58.55 cd	10.78 bcd

Genotypes	Fruit weight (gm)	Fruit diameter (mm)	No of segments/fruit
NCRP-93	61.44 f	46.28 ef	11.00 abc
NCRP-94	62.40 f	41.67 f	9.33 fgh
NCRP-95	166.60 a	68.72 a	11.40 abc
NCRP-98	140.60 abc	64.27 abc	8.80 gh
NCRP-99	80.84 ef	53.65 de	8.83 gh
NCRP-100	134.80 abc	63.63 abc	8.46 h
NCRP-101	79.09 ef	52.02 de	8.50 h
Mean	**117.15**	**57.72**	**10.24**
P-value	**	**	**
$LSD_{(0.05)}$	**36.66**	**7.01**	**0.86**
CV %	**18.90**	**7.34**	**5.09**

Chemical Properties of Mandarin Genotypes

Table 5 reveals that juice volume, juice weight, total soluble solid % (TSS %) and Titrable acid (TA %) were statistically significant.

Fruit Juice Volume

Fruit juice volume was found to vary between 28.87 ml and 91.27 ml with a mean value of 55.50 ml among test genotypes. Difference in fruit juice volume was statistically significant. It is evident from table 5 that fruit juice volume was highest (91.27 ml) in NCRP-95 followed by NCRP-81 (86.43 ml), NCRP-89 (70.23 ml) and NCRP-5 (68.2 ml), respectively. NCRP-94 was observed to give the least (28.87 ml) juice volume. Other genotypes giving lower fruit juice volume were NCRP-93 (30.73 ml), NCRP-99 (35.97 ml) and NCRP-11 (35.70 ml), respectively.

Fruit Juice Weight

Fruit juice weight varied between 27.66 gm and 93.37 gm with a mean value of 57.15 gm. NCRP-95 had the highest juice weight (93.37gm) followed by NCRP-81 (88.72 gm), NCRP-89 (71.4 gm) and NCRP-5 (68.83 gm), respectively. NCRP-94 produced the least fruit juice weight (27.66 gm) among the entries under evaluation. NCRP-93 (31.53 gm), NCRP-99 (36.13 gm) and NCRP-11 (43.34 gm) were other genotypes with lesser fruit juice weight (table 5).

Total Soluble Solid (TSS %)

The data in table 5 shows that TSS varied significantly between 7.58 % and 13.95% with the mean value of 10.93 %. The highest TSS was recorded in NCRP-93 (13.95%) followed by NCRP-94 (12.8%), NCRP-1 (12.43%) and NCRP-8 (11.97%).NCRP-6 had

the least TSS % (7.58%). Similarly, NCRP-5 (7.73%), NCRP-95 (8.37%), NCRP-82 (9.47%) and NCRP-80 (9.52%) were other genotypes with lower TSS.

Titrable acid (TA %)

Table 5 reveals that TA% was highly variable ranging between 3.14% and 9.35% with the mean value of 4.61 %. NCRP- 89 recorded the highest TA (9.35%) followed by NCRP-90 (6.93%), NCRP-93 (6.43%) and NCRP-6 (5.38%). NCRP-100 had the least TA (3.14%) among the test genotypes.

Table 5: Fruit chemical properties of mandarin genotypes at NCRP in 2016/17 (2073/74)

Genotypes	Juice Volume (ml)	Juice weight (gm)	TSS %	TA%
NCRP-1	53.03 cdefg	53.57 cdefg	12.43 cd	3.91 cd
NCRP-5	68.20 bc	68.83 bcd	7.73 i	4.54 bcd
NCRP-6	64.34 cd	65.62 cde	7.58 i	5.38 bcd
NCRP-8	44.93 defgh	45.78 defgh	11.97 de	3.58 cd
NCRP-10	45.95 defgh	46.97 defgh	11.83 de	3.50 cd
NCRP-11	42.50 efgh	43.34 efgh	11.73 de	3.57 cd
NCRP-80	66.10 bcd	66.17 cde	9.52 h	3.60 cd
NCRP-81	86.43 ab	88.72 ab	9.62 h	3.33 d
NCRP-82	65.40 cd	66.35 cde	9.47 h	3.19 d
NCRP-89	70.23 bc	71.04 bc	13.42 ab	9.35 a
NCRP-90	55.80 cdef	56.48 cdef	11.77 de	6.93 abc
NCRP-92	57.23 cdef	58.05 cdef	11.45 ef	3.38 d
NCRP-93	30.73 h	31.53 gh	13.95 a	6.43 abcd
NCRP-94	28.87 h	27.66 h	12.80 bc	4.85 bcd
NCRP-95	91.27 a	93.37 a	8.37 i	3.58 cd
NCRP-98	62.13 cde	65.83 cde	11.30 ef	3.90 cd
NCRP-99	35.97 fgh	36.13 fgh	11.87 de	3.86 cd
NCRP-100	52.53 cdefg	53.21 cdefg	10.83 fg	3.14 d
NCRP-101	32.87gh	47.18 defgh	10.13 gh	7.66 ab
Mean	**55.50**	**57.15**	**10.93**	**4.61**
P-value	**	**	**	**
$LSD_{(0.05)}$	**18.74**	**20.10**	**0.76**	**2.95**
CV %	**20.39**	**21.24**	**4.20**	**38.64**

3.1.2.2 Sweet orange

Sweet orange (*Citrus sinensis* Osbeck) is the second most important citrus fruit after Mandarin in Nepal. The major sweet orange growing districts include: Sindhuli,

Ramechap, Baitadi, Doti, Dadeldhura, Palpa, Lamjung and Rukum. The harvesting time of present local varieties remains only two months during December-January and beyond this period, Nepal imports fresh sweet orange fruit as well as processed fruit juice throughout the year.

Thus, NCRP has focused on variety selection of this species, so that there will be variety diversity for expanding the fruit harvesting period beyond normal season, especially for early and late harvesting seasons. With this objective, varietal evaluation of sweet orange including 23 exotic and local varieties have been continued since 2064/65.

The performance of the sweet orange genotypes being evaluated in NCRP, Paripatle is described as follows.

Fruit characteristics and yield of different genotypes of sweet oranges

Fruit characteristics and yield attributes like individual fruit weight, fruit diameter, pulp weight, number of fruits/plant and weight of fruits/plant were statistically significant due to the effect of different genotypes of sweet orange (Table 6).

Individual Fruit Weight

The data in Table 6 shows that the individual fruit weight was statistically significant among different genotypes. Fruit weight varied from 99.15 gm (NCRP-14) to 178.6 gm (NCRP-84) with the mean value of 145.16 gm. NCRP-84 (178.6 gm), NCRP-83 (173.6 gm), NCRP-16 (1169.87 gm) possessed higher individual fruit weight. Lower individual fruit weights were recorded on genotypes NCRP-14 followed by NCRP-13 (107.3 gm) and NCRP-34 (120.9 gm).

Individual Fruit Diameter

Individual fruit diameter was statistically variable and ranged between 55.6 mm (NCRP-14) and 68.97 mm (NCRP-19) with the mean value of 64.30 mm. Genotype NCRP-19 had the highest fruit diameter (68.97 mm) followed by NCRP-84 (68.58 mm) and NCRP-27 (68.45 mm). In contrast, individual fruit diameter was considerably low of genotype NCRP-14 (55.6 mm), NCRP-13 (58.23 mm) and NCRP-23 (60.81 mm) (table 6).

Pulp Weight

The pulp weight differed significantly among genotypes and ranged between 47.98 gm and 143.2 gm with mean value of 95.16 gm. The genotype NCRP-22 (143.2 gm) gave highest pulp weight followed by NCRP-83 (125.8 gm) and NCRP-84 (119.1 gm). Lower pulp weights were observed in genotypes NCRP-14 (47.98 gm), NCRP-13 (68.8 gm), NCRP-23 (81.23 gm) and so on (table 6).

Number of Fruits/tree

The number of fruits/plant was highly variable from 14.17 to 121.7 with the mean value of 69.43. NCRP -87 recorded the highest number of fruits/ plant i.e. 121.7 followed by NCRP-86 (113.8) and NCRP-27 (110.8). Genotypes like NCRP-83 (14.17), NCRP-19 (18.67), NCRP-35 (30.67), NCRP-85 (31.17) and NCRP-31 (33.83) were found to produce significantly lower number of fruits per plant (table 6).

Fruit yield /tree

Total weight of fruits/plant was highly variable and ranged between 1.74 kg and 19.13 kg with a mean value of 8.05 kg. The genotype NCRP-96 gave the highest yield/ tree (19.13 kg) followed by NCRP-27 (15.7 kg) and NCRP-84 (14.76 kg). The genotype NCRP-83 produced the least fruit /tree (1.74 kg) per tree. NCRP-23 (2.39 kg), NCRP-19 (2.53 kg) and NCRP-34 (3.12 kg) were other low yielding genotypes/accessions (table 6).

Table 6: Fruit characteristics of sweet orange genotypes at NCRP in 2016/17 (2073/74)

Genotypes	Fruit Weight (gm)	Fruit Diameter (mm)	Pulp Weight (g)	No of Fruits / tree	Fruit yield / tree (kg)
NCRP-13	107.30 ef	58.23 de	68.80 de	49.67 bcdef	4.32 de
NCRP-14	99.15 f	55.60 e	47.98 e	51.67 bcdef	4.50 de
NCRP-16	169.80 ab	67.90 ab	102.50 bcd	53.83 bcdef	7.65 bcde
NCRP-19	158.20 abcd	68.97 a	97.53 bcd	18.67 f	2.53 de
NCRP-22	168.1 ab	65.97 abc	143.20 a	102.00 bcde	10.80 bcd
NCRP-23	125.1 cdef	60.81 cde	79.01 de	22.67 ef	2.39 e
NCRP-27	165.70 abc	68.45 ab	89.56 cd	110.80 bcd	15.70 ab
NCRP-31	150.7 abcd	62.68 abcd	99.43 bcd	33.83 cdef	4.54 de
NCRP-33	153.5 abcd	65.65 abc	101.10 bcd	56.67 bcdef	6.90 cde
NCRP-34	120.90 cde	63.62 abcd	82.55 d	30.67 def	3.12 de
NCRP-83	173.60 a	67.81 ab	125.80 ab	14.17 f	1.74 e
NCRP-84	178.60 a	68.58 a	119.10 abc	100.70 bcde	14.76 abc
NCRP-85	138.20 abcdef	64.02 abcd	93.76 bcd	31.17 def	3.40 de
NCRP-86	141.00 abcde	66.13 abc	102.40 bcd	113.80 bc	14.49 abc
NCRP-87	143.60 abcde	62.37 bcd	88.64 cd	121.70 b	12.83 abc
NCRP-96	129.00 bcdef	61.73 cd	81.23 de	18.80 a	19.13 a
Mean	**145.16**	**64.30**	**95.16**	**69.43**	**8.05**
P-value	**	**	**	**	**
$LSD_{(0.05)}$	**36.39**	**5.22**	**31.10**	**69.82**	**7.28**
CV %	**15.03**	**4.87**	**19.60**	**60.31**	**51.94**

Physio-chemical properties of different genotypes of sweet orange

Physio-chemical properties (juice volume, juice weight, TA% and TSS %) of sweet orange genotypes/accessions under variety evaluation experiment were significantly different as presented in table 7.

Fruit juice Volume

The volume of fruit juice was significantly different among test genotypes and ranged between 23.13 ml and 71.93 ml with mean value of 47.05 ml. The genotype NCRP-27 was found to give the highest juice volume (71.93 ml) followed by NCRP-31 (67.77 ml), and NCRP-16 (65.2 ml). The genotype NCRP-14 gave the least juice volume (32.13 ml). Similarly, NCRP-13 (32.87 ml), NCRP-22 (33.73 ml) yielded low fruit juice volume (table 7).

Fruit Juice Weight

It is obvious from Table 7 that difference in juice weight among test genotypes was statistically significant and ranged between 31.98 gm and 72.55 gm with mean value of 47.12 gm. Highest fruit juice weight (72.55 gm) was observed in NCRP-27 followed by NCRP-16 (67.25 gm), NCRP-84 (58.15 gm) and NCRP-19 (58.04 gm) and NCRP-87 (51.96 gm). The least juice weight was recorded in NCRP-14 (31.94 gm). Other genotypes with lower juice weight were NCRP-13 (32.41 gm), NCRP-22 (33.81 gm) (table 7).

Titrable Acid (TA %)

Among the tested genotypes percent of TA ranged from 2.66% to 8.54% with mean value of 4.84%. The TA percent was remarkably high in NCRP-86 (8.54%). Other genotypes with higher percentage of TA were NCRP-13 (7.97%) and NCRP-34 (6.81%) whereas NCRP-83 recorded significantly the lowest TA (2.66%). Other genotypes with lower values of TA were NCRP-84 (2.83%), NCRP-96 (3.1%) and NCRP-22 (3.1%) (table 7).

Total Soluble Solids (TSS %)

Among the tested genotypes the percent TSS varied from 10.1% to 14.43% with the mean value of 12.54%. TSS% was found significantly higher in genotypes such as NCRP-22 (14.43%), NCRP-31 (13.6%), NCRP-13 (13.4%), NCRP-33 (13.33%) and NCRP-84 (13.05%). Lower TSS% values were observed in genotypes NCRP-14 (11.5%), NCRP-19 (11.53%), NCRP-23 (11.87%) and so on (table 7).

Table 7: Physio-chemical Properties of Sweet Orange Genotypes at NCRP in 2015/16 (2073/74)

Genotypes	Juice volume (ml)	Juice weight (gm)	TSS%	TA%
NCRP-13	32.87 f	32.41 g	13.40 ab	7.967 a
NCRP-14	32.13 f	31.94 g	10.10 e	6.35 bc
NCRP-16	65.20 ab	67.25 ab	12.87 abcd	5.03 d
NCRP-19	57.87 bc	58.04 bc	11.53 cde	3.90 f
NCRP-22	33.73 ef	33.81 fg	14.43 a	3.10 fg
NCRP-23	43.27 def	42.96 defg	11.87 bcd	3.40 fg
NCRP-27	71.93 a	72.55 a	12.17 bcd	4.88 de
NCRP-31	67.77 ab	36.23 fg	13.60 ab	5.70 cd
NCRP-33	44.27 def	44.10 defg	13.33 abc	4.06 ef
NCRP-34	50.85 cd	50.39 cde	11.50 de	6.81 b
NCRP-83	46.93 cd	46.93 cdef	12.95 abcd	2.66 g
NCRP-84	57.83 bc	58.15 bc	13.05 abcd	2.83 g
NCRP-85	43.07 def	42.28 defg	12.55 bcd	3.86 f
NCRP-86	38.20 def	37.71 efg	12.27 bcd	8.54 a
NCRP-87	51.27 cd	51.96 cd	12.22 bcd	5.21 d
NCRP-96	46.57 cde	47.21 cdef	12.73 abcd	3.10 fg
Mean	47.05	47.12	12.54	4.84
P-value	**	**	**	**
$LSD_{(0.05)}$	11.56	11.76	1.54	0.87
CV %	14.74	14.97	7.35	10.81

3.1.2.3 Tangor

The tangor is a citrus fruit that is deliberate or accidental hybrid of the mandarin orange (*C. reticulata*) and sweet orange (*C. sinensis*). The fruit has thick rind that is easy to peel and its bright orange pulp is sour-sweet and full-flavored.

Fruit characteristics and physio-chemical properties of tangor

The (table 8) illustrates that fruit weight, fruit diameter, juice volume, TSS %, TA %, number of fruits per plant and total fruit weight per plant were statistically significant.

Fruit weight

The fruit weight varied from 72.22 gm to 188.00 gm with the mean value of 129.96 gm (table 8). The highest fruit weight was recorded from NCRP-45 (188.00 gm), NCRP-79 (187.00 gm) and NCRP-77 (182.30 gm). The lowest fruit weight was recorded from NCRP-102 (72.22 gm), NCRP-75 (79.56 gm) and NCPR-72 (86.62 gm).

Fruit diameter

The fruit diameter ranged from 49.76 mm to 79.45 mm with mean value of 65.20 mm (table 8). The highest fruit diameter was obtained from NCRP-77 (79.45 mm), NCRP-79 (77.48 mm) and NCRP-76 (76.93mm). The lowest fruit diameter was recorded from NCRP-102 (49.76 mm), NCRP-75 (52.76 mm) and NCRP-72 (58.24 mm).

Juice volume

The juice volume ranged from 23.70 ml to 62.40 ml with average value of 44.99 ml (table 8). The highest juice volume was recorded from NCRP-79 (62.40 ml), NCRP-77 (61.80 ml) and NCRP-45 (54.13 ml). The lowest juice volume was recorded from NCRP-74 (23.70 ml), NCRP-102 (33.90 ml) and NCRP-72 (38.00 ml).

TSS %

The TSS % ranged from 10.90 % to 20.95% with average value of 14.17 % (table 8). The highest TSS % was recorded from NCRP-72 (20.95 %), NCRP-102 (16.72 %) and NCRP-73 (15.57 %). The lowest TSS % was recorded from NCRP-45 (10.90 %), NCRP-77 (11.20 %) and NCRP-79 (11.30 %).

TA %

The TA % ranged from 6.01 % to 12.08 % with mean value of 8.73 % (table 8). The highest TA % was recorded from NCRP-76 (12.08 %), NCRP-102 (10.55 %) and NCRP-45 (10.04 %). The lowest TA % was recorded from NCRP-74 (6.01 %), NCRP-72 (6.26 %) and NCRP-73 (6.65 %).

Number of fruits per plant

The number of fruits per plant varied from 40.50 to 109.30 with the mean value of 70.09 (table 8). The highest number of fruits was recorded from NCRP-76 (109.30), NCRP-102 (97.50) and NCRP-75 (89.50). The lowest number of fruits was recorded from NCRP-72 (40.50), NCRP-73 (44.66) and NCRP-77 (50.33).

Total fruit weight per plant

The total fruit weight per plant ranged from 3.86 kg to 23.68 kg with mean weight of 10.40 kg (table 8). The highest fruit weight per plant was recorded from NCRP-76 (23.68 kg) and NCRP-45 (17.00 kg). The lowest fruit weight per plant was recorded from NCRP-72 (3.86 kg), NCRP-73 (5.03 kg) and NCRP-74 (6.67 kg).

Table 8: Fruit characteristics and physio-chemical properties of tangor genotypes at NCRP in fiscal year 2073/74 (2016/17)

Genotype	Fruit weight (gm)	Fruit diameter (mm)	Juice volume (ml)	TSS %	TA %	Number of fruits per plant	Total fruit weight per plant (kg)
NCRP-72	86.62	58.24	38.00	20.95	6.26	40.50	3.86
NCRP-102	72.22	49.76	33.90	16.72	10.55	97.50	7.10
NCRP-76	156.70	76.93	48.07	11.72	12.08	109.30	23.68
NCRP-77	182.30	79.45	61.80	11.20	8.67	50.33	12.33
NCRP-79	187.00	77.48	62.40	11.30	8.82	61.00	10.90
NCRP-45	188.00	71.94	54.13	10.90	10.04	61.00	17.00
NCRP-75	79.56	52.76	41.00	15.40	9.49	89.50	7.00
NCRP-74	107.00	60.31	23.70	13.75	6.01	77.00	6.67
NCRP-73	110.20	59.90	41.93	15.57	6.65	44.66	5.03
Mean	**129.96**	**65.20**	**44.99**	**14.17**	**8.73**	**70.09**	**10.40**
P-value	**	**	**	**	**	**	**
$LSD_{(0.05)}$	**157.9**	**37.01**	**42.04**	**10.93**	**6.79**	**79.83**	**21.01**
CV %	**14.73**	**5.42**	**18.67**	**18.12**	**8.69**	**29.35**	**43.01**

3.2 POST-HARVEST RESEARCH

3.2.1 Effect of different chemicals on enhancing storage life of mandarin (var. Khoku) in cellar store

Citrus fruits are cultivated all over the world in tropical and sub-tropical regions having suitable soil and climatic conditions. Mid hills of Nepal ranging from 800 to1400 masl altitude all across the country are considered favorable for all types of citrus fruits cultivation. However pumelo, acid lime and lemon can also be cultivated successfully in up-land condition of terai, inner terai, foothills and river basin areas of Nepal. Citrus crops cover about 30% of the total area under fruit cultivation. Citrus crops are potential exportable commodities particularly to India, Bangladesh and China. At present, major citrus producing districts of Nepal having more than 1000 ha area are Taplejung, Tehrathum, Dhankuta, Ramechhap, Sindhuli, Kavrepalanchowk, Lamjung, Syangja, Salyan and Dailekh.

Citrus production and international trade in fresh citrus fruit has increased manifold during the last decade. World citrus production is around 73.3 million metric tons, with Brazil being largest producer, while European Union being the largest importer of citrus (Anonymous, 2004; FAO, 2003). Although citrus production in many citrus growing countries has increased, however, the overall profitability of the industry in developing countries has been limited by high postharvest losses due to the lack and/or use of proper postharvest handling system of fresh fruit. From sustainability and economic perspectives, there will be less investment needed to improve the situation through better postharvest management of the existing produce, the production area to compensate for these losses (Kader, 2002).

Based on secondary data source (HARP, 2002) there are remarkable losses in case of fresh fruit and vegetable in post-production stage. The loss reported 20-30% and this figure could exceed 50% under adverse condition. Losses reported in case of citrus fruits have been estimated between 15-20% (HARP, 2002). In Nepal, post-harvest loss observed in oranges is up to 29% (DFTQC, 2002). Bastakoti and Gotame (2013) reported that the fruit harvested at 26-50% yellow stage had minimum weight loss and rotting percentage accompanied by good taste, freshness, firmness and higher degree of overall acceptability after the storage of 90 days in a modified cellar store. The storage losses of mandarin fruits were found to be 5% during 2 to 4 days in Dharan Krishi Bazaar while 40.1% during 21 days of storage in room condition (Bhattarai *et al,* 2013). Therefore, this research was carried out to fulfill the following objectives:

- To extend storage life of mandarin fruits in cellar store with minimum fruit loss.

Methodology

The experiment was carried out to identify suitable chemicals that enhance storage life of mandarin at NCRP, Paripatle, Dhankuta beginning from the fiscal year 2073/74. Cellar store constructed at NCRP was used for the experiment. The experiment was carried out by completely randomized block design and were given seven treatments and replicated thrice. The treatments given are stated below:

T: Bavistin spray @ 2gm/lt of water 45 days before harvest
T2: Sodium bicarbonate spray @ 6.33gm/lt of water 45 days before harvest
T3: Bavistin spray @ 2gm/lt of water 45 and 30 days before harvest
T4: Sodium bicarbonate spray @ 6.33gm/lt of water 45 and 30 days before harvest
T5: Bavistin spray @ 2gm/lt of water 45, 30 and 15 days before harvest
T6: Sodium bicarbonate spray @ 6.33gm/lt of water 45, 30 and 15 days before harvest
T7: Control

The observation was taken at 15 days interval for 4 times on physical and chemical parameters like fruit weight, juice volume, TSS %, TA % and organoleptic taste.

Result and discussion

The experiment was carried out to identify suitable chemical that enhance storage life of mandarin at NCRP, Paripatle, Dhankuta beginning from the fiscal year 2072/73. All the treated fruits were stored in cellar store for 60 days and observations on different parameters were taken four times at 15, 30, 45 and 60 days at 15 days interval. Five kilograms of fruits were initially taken for each treatment and subjected to observations at 15 days interval for all parameters. Table 9 and 10 illustrates that there was no significant difference in fruit weight, juice volume, TSS % and TA % among various treatments in any storage duration.

Table 9: Effect of chemicals on fruit weight and juice content of mandarin during storage in cellar store 2016/17 (2073/74)

Treatments	Fruit wt (kg)	Fruit weight (kg)				Juice volume (ml)			
		15 day	30 day	45 day	60 day	15 day	30 day	45 day	60 day
Bavistin spray 45 days before harvest	5	4.82	4.25	3.83	3.12	44.50	34.00	20.50	41.50
Sodium bicarbonate spray 45 days before harvest	5	4.55	4.12	3.69	3.24	54.00	30.00	18.50	39.00
Bavistin spray 45 and 30 days before harvest	5	4.81	4.55	3.54	3.09	41.50	25.50	23.50	38.50
Sodium bicarbonate spray 45 and 30 days before harvest	5	4.80	3.49	2.69	2.19	43.00	30.00	32.00	42.00
Bavistin spray 45, 30 and 15 days before harvest	5	4.86	4.33	3.99	3.79	59.50	40.50	27.50	44.50
Sodium bicarbonate spray 45, 30 and 15 days before harvest	5	4.96	4.41	3.62	2.87	58.00	34.50	35.50	49.00
Control	5	4.81	4.07	3.65	3.08	51.00	44.25	28.50	37.25
Mean		**4.80**	**4.17**	**3.58**	**3.06**	**50.21**	**34.11**	**26.57**	**41.68**
P-value		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
$LSD_{(0.05)}$		**0.40**	**1.19**	**1.45**	**1.35**	**29.39**	**22.41**	**21.20**	**31.64**
CV%		**3.44**	**10.97**	**10.45**	**18.01**	**23.92**	**32.84**	**39.06**	**31.03**

Table 10: Effect of chemicals on TSS % and TA % of mandarin during storage in cellar store 2016/17 (2073/74)

Treatments	TSS %				TA %			
	15 day	30 day	45 day	60 day	15 day	30 day	45 day	60 day
Bavistin spray 45 days before harvest	13.25	13.25	14.50	16.00	2.00	2.70	3.10	2.75
Sodium bicarbonate spray 45 days before harvest	12.75	15.25	15.50	15.50	2.00	2.90	3.05	2.30
Bavistin spray 45 and 30 days before harvest	14.50	16.25	15.50	14.00	1.40	3.05	3.15	2.70
Sodium bicarbonate spray 45 and 30 days before harvest	14.25	16.25	14.50	14.00	1.20	2.85	3.10	2.60
Bavistin spray 45, 30 and 15 days before harvest	14.00	14.25	14.00	14.50	1.30	2.95	2.90	2.55
Sodium bicarbonate spray 45, 30 and 15 days before harvest	14.25	14.00	15.00	15.00	1.10	2.85	2.95	2.25
Control	14.50	15.00	15.00	14.50	1.75	3.13	2.95	3.08
Mean	**13.93**	**14.46**	**14.86**	**14.79**	**1.54**	**2.92**	**3.03**	**2.60**
P-value	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
$LSD_{(0.05)}$	**1.61**	**3.82**	**1.93**	**2.64**	**0.75**	**0.48**	**0.33**	**1.32**
CV%	**4.73**	**4.43**	**4.28**	**7.31**	**19.87**	**17.70**	**13.17**	**20.67**

3.3 NURSERY MANAGEMENT

For a sustainable and profitable commercial citrus industry, trees should be propagated from citrus root stocks and bud wood that are true to type genetically and tested to be free from potentially harmful viruses and other pathogens. Nurseries are to be adopted in

the propagation of those trees. An orchard that was established from sub-standard nursery stock will never be as vigorous, productive and profitable as those established from high quality and disease free materials. Citrus have a high rate of natural mutation so; care must be taken to ensure bud wood which is only taken from superior trees. In addition, citrus trees may be infected with diseases that show no symptoms in young plants, but they will have serious implications over the life of the tree (Pyle, 2012). In order to use certified propagation materials five different but closely related programs are needed in any citrus industry:

- A quarantine program to ensure the safe introduction of new germplasms introduced in to the country.
- A clean stock program to produce sources of pathogen free propagating stock of new and existing commercial varieties.
- A parent tree program in which parent trees of each cultivar needs to be virus indexed and certified.
- A program of horticultural evaluation to ensure that parent trees reflect the genetics attributes of a variety, without any disadvantageous mutation.
- A quality assurance program whether a range of best practices have been adopted during the nursery propagation cycle to growers the assurance that the end product is of high quality and is free of diseases and pest.

3.3.1 On-farm rootstock evaluation of kinnow mandarin and acid lime recommended for terai region of Nepal

Acid lime is one of the important citrus crops of Nepal. Traditionally, acid lime cultivation is limited to a range of 800 m to 1400 masl in the mid hills producing a very small volume during normal season on September to November. The current production is far below to meet the domestic demand that Nepal imports more than 90% of fresh lime fruit demand in the country every year. Moreover, the cultivation practice is attributed to marginal land with poor yielding varieties. Similarly, the potential of cultivating range could be much wider from 125 masl terai to 1800 masl high hills in Nepal (Shrestha *et al*, 2012). Thus, Nepal has enormous scope of increasing production and productivity by adopting better varieties along with improved management. Thus, variety selection and evaluation of acid lime was carried out in different terai regions during 2062-2067 and two varieties of acid lime (NCRP-49 and NCRP-55) were identified ideal for terai region of Nepal. These varieties are found very popular among farmers in recent years and most of the farmers are commercially cultivating these two varieties. Similarly, according to DADO Sunsari and Morang, most of the kinnow mandarin grafted on trifoliate orange died within 6-7 years. At the same time, kinnow mandarin is becoming popular in Jhapa district and more than 100 saplings of kinnow have been planted. Presently, these two varieties are grafted on trifoliate orange.

According to DADO Morang (RATWG, 2013), these varieties suffer from canker disease when grafted on trifoliate orange but found traces when grafted on pumelo. Thus, this experiment was conducted to fulfill the following objectives:

- To identify compatible rootstock for acid lime and kinnow mandarin.
- To enhance productive life of kinnow mandarin and acid lime in terai region

Methodology:

To conduct this experiment, seedlings of trifoliate orange, citrange, rangpur lime, pumelo, sour orange and rough lemon were raised as a rootstock in a nursery of NCRP, Dhankuta. Healthy scion of NCRP-49, NCRP-55 and Kinnow mandarin were grafted on those seedlings by shoot tip method and raised in nursery. Individual seedling was considered as a single treatment as stated below:

Treatment (rootstock)		Scion	Scion	Scion
T1 – Pumelo	+	NCRP-49	NCRP-55	Kinnow
T2 – Rangpur lime	+	NCRP-49	NCRP-55	Kinnow
T3 – Seti jyamire	+	NCRP-49	NCRP-55	Kinnow
T4 – Kali jyamre	+	NCRP-49	NCRP-55	Kinnow
T5 – Citrange	+	NCRP-49	NCRP-55	Kinnow
T6 – Trifokiate orange	+	NCRP-49	NCRP-55	Kinnow

These grafted saplings were planted by Randomized Complete Block Design in four different location *viz.* RARS, Tarahara; Itahara, Morang (Madan Bhandari Bhawan); Rupkanchanpur, Saptari (Sahjaadi Begum); and RARS, Parwanipur.

Result and discussion

The result projected in table 11 illustrates that plant height, rootstock diameter, graft union diameter, scion diameter and fruits per tree were statistically significant.

Plant height

Plant height varied from 66.67 cm to 249.83 cm with mean value of 171.16 cm (table 11). The highest plant height was noted form Pumelo+NCRP-55 (249.83 cm) followed by seti jyamire + NCRP-55 (215.00 cm), seti jyamire + NCRP-49 (213.33 cm) and rangpur lime + NCRP-49 (208.33 cm). In contrast, lowest plant height was recorded from rangpur lime + NCRP-55 (66.67 cm) followed by trifoliate + NCRP-55 (93.33 cm) and kali jyamire + NCRP-49 (97.50 cm).

Rootstock diameter

Rootstock diameter was found significant varying range from 20.37 mm to 73.69 mm with mean value of 51.53 mm (table 11). The highest rootstock diameter was observed from rangpur lime + NCRP-49 (73.69 mm), pumelo + NCRP-49 (66.91 mm) and seti

jyamire + NCRP-55 (65.76 mm). The lowest rootstock diameter was obtained from kali jyamire + NCRP-49 (20.37 mm) and kali jyamire + NCRP-55 (29.37 mm).

Graft union diameter

Graft union diameter ranged from 24.30 mm to 70.26 mm with mean value of 50.87 mm (table 11). The highest graft union diameter was observed from rangpur lime + NCRP-49 (70.26 mm) followed by pumelo + NCRP-49 (66.95 mm) and pumelo + NCRP-55 (66.07 mm). The lowest graft union diameter was noted from kali jyamire + NCRP-49 (24.30 mm) followed by kali jyamire + NCRP-55 (30.03 mm) and rangpur lime + NCRP-55 (33.72 mm).

Scion diameter

Scion diameter varied from 22.38 mm to 58.42 mm with the mean value of 43.82 mm (table 11). The highest scion diameter was noted from pumelo + NCRP-55 (58.42 mm), seti jyamire+NCRP-49 (58.38 mm), rangpur lime + NCRP-49 (57.59 mm) and pumelo+NCRP-49 (57.24 mm). The lowest scion diameter was recorded from kali jyamire + NCRP-49 (22.38 mm), trifoliate + NCRP-55 (24.64 mm), kali jyamire + NCRP-55 (29.22 mm) and rangpur lime + NCRP-55 (29.33 mm).

Number of fruits per plant

The number of fruits per plant varied from 0.00 to 103.33 with the mean value of 34.91 (table 11). The highest number of fruits per plant was found in seti jyamire + NCRP-55 (103.33) followed by pumelo + NCRP-55 (62.33) and citrange + NCRP-49 (60.00). The lowest number of fruits per plant was recorded from kali jyamire + NCRP-49 (0.00) followed by trifoliate+ NCRP55 (10.67), trifoliate + NCRP-49 (12.67) and kali jyamire + NCRP-55 (15.33).

Table 11: Performance of six different rootstocks on acid lime in Tarahara, Morang in 2016

Treatment	Plant height (cm)	Rootstock diameter (mm)	Graft union diameter (mm)	Scion diameter (mm)	Fruit per plant
Pumelo * NCRP-55	249.83	61.30	66.07	58.42	62.33
Rangpur lime * NCRP-55	66.67	36.30	33.72	29.33	27.67
Seti jyamire * NCRP-55	215.00	65.76	57.48	45.24	103.33
Kali jyamire * NCRP-55	137.50	29.37	30.03	29.22	15.33
Citrange * NCRP-55	166.83	58.20	51.01	48.75	49.00
Trifoliate * NCRP-55	93.33	34.45	34.95	24.64	10.67
Pumelo*NCRP-49	206.67	66.91	66.95	57.24	18.33
Rangpur lime * NCRP-49	208.33	73.69	70.26	57.59	29.67
Seti jyamire * NCRP-49	213.33	58.20	57.09	58.38	18.33
Kali jyamire* NCRP-49	97.50	20.37	24.30	22.38	0.00
Citrange * NCRP-49	197.50	53.50	56.96	47.21	60.00
Trifoliate * NCRP-49	176.16	49.88	52.83	40.61	12.67
Mean	**171.16**	**51.53**	**50.87**	**43.82**	**34.91**
P-value	**	**	**	**	**
CV %	**27.61**	**25.81**	**24.00**	**27.93**	**34.91**

3.3.2 Effect of different soil mixture on growth and development of grafted saplings of mandarin var. Khoku

The selection of the growing media is one of the most important decisions in growing of seedlings and saplings. The physical, chemical and biological characteristics of the growing media affect seedlings growth and other aspects of nursery operations as well, the purposes of media are to physically support the plant and to supply adequate oxygen, water and nutrient for proper root functions The ideal medium should have the following properties: it must be porous, sterile, light weighted, holds sufficient water, consistent in quality and supplies of necessary mineral nutrients, and it should be free of disease organisms, insects, weed seeds and poisonous products. Soil mixtures with different organic residues and compost are getting used recently.

Methodology

The study was carried out to determine the best suitable soil mixture for growing grafted saplings of mandarin cv. Khoku for good growth and development. The experiment was carried out in screen house on NCRP, Dhankuta in 2073/74. Eight to ten months old healthy scions from healthy mother plant and one year old trifoliate rootstock were grafted by shoot tip method and transferred to poly bags containing different soil mixture. Seven different soil mixtures were prepared which are stated below. Ten grafted

saplings each for seven different soil mixtures were planted on poly bags. The experiment was designed at completely randomized block design and replicated ten times. Observations on plant height, scion height and rootstock height were taken. The composition of different soil mixtures are listed below:

T1- Surface soil + Sand + FYM (1:1:1)
T2- Surface soil + Sand (1:1)
T3- Surface soil + Sand + Vermicompost (1:1:1)
T4- Surface soil + Vermicompost (1:1)
T5- Forest soil + Sand (1:1)
T6- Forest soil + Sand + FYM (1:1:1)
T7- Forest soil + Sand + Vermicompost (1:1:1)

Result and discussion

Table reveals that all three plant characteristics *viz.* plant height, scion height and rootstock height were statistically significant.

Plant height

Plant height was found ranging from 26.67 cm to 52.00 cm with average height of 44.38 cm (Table 12). The highest plant height was found highest with combination of growing media of surface soil, sand and FYM (52.00 cm) followed by forest soil, sand and FYM (50.67 cm) and surface soil, sand and vermicompost (50.33 cm). The lowest plant height was observed from combination of growing media of forest soil and sand (26.67 cm).

Scion height

Scion height varied from 19.33 cm to 39.00 cm with mean scion height of 32.67 cm (Table 12). The highest scion height was seen with combination of growing media of surface soil, sand and FYM (39.00 cm) followed by surface soil, sand and vermicompost (36.37 cm) and forest soil, sand and FYM (36.67 cm). The lowest plant height was seen with combination of growing media of forest soil and sand (19.33 cm).

Rootstock height

Rootstock height was found ranging from 7.33 cm to 14.00 cm with average rootstock height of 11.71 cm (Table 12). The highest rootstock height was observed from combination of growing media of forest soil and FYM (14.00 cm) followed by growing media of surface soil, sand and vermicompost (13.67 cm) and growing media of surface soil, sand and FYM (13.00 cm). The lowest rootstock height was observed from combination of growing media of forest soil and sand (7.33 cm).

Table 12: Physical characteristics of grafted saplings raised under different growing media at NCRP 2016/17 (2073/74)

Treatment	Plant Height (cm)	Scion Height (cm)	Rootstock Height (cm)
Surface soil + Sand + FYM (1:1:1)	52.00 a	39.00 a	13.00 a
Surface soil + Sand (1:1)	46.00 ab	34.67 a	11.33 b
Surface soil + Sand + Vermicompost (1:1:1)	50.33 ab	36.67 a	13.67 a
Surface soil + Vermicompost (1:1)	44.33 ab	33.00 a	11.33 b
Forest soil + Sand (1:1)	26.67 c	19.33 b	7.33 c
Forest soil + Sand + FYM (1:1:1)	50.67 ab	36.67 a	14.00 a
Forest soil + Sand + Vermicompost (1:1:1)	40.67 b	29.33 ab	11.33 b
Mean	**44.38**	**32.67**	**11.71**
P-value	**	**	**
$LSD_{(0.05)}$	**9.76**	**10.25**	**1.39**
CV %	**12.36**	**17.63**	**6.67**

3.3.3 Identification of appropriate stage of trifoliate orange for maximum seed germination

The harvesting time is one of the critical steps in seed production and germination. It is necessary to harvest at a time as close as possible to the physiological maturity, that is, after the stabilization of dry matter translocation to the seeds, when they reach the maximum germination and vigor potential. Timely harvest of mature seed is important in protecting and maintaining seed quality. Seed harvested prior to attainment o physiological maturity remain immature, under developed and store less food reserve as compared to those harvested at physiological maturity. Seed harvested at physiological maturity is considered to have maximum viability and vigor.

Methodology

The experiment was carried out to identify appropriate stage of trifoliate orange for maximum seed germination at NCRP, Paripatle, Dhankuta starting from the fiscal year 2073/74. Trifoliate fruits were harvested from trifoliate orchard located at NCRP. Fruits were harvested at three different stage *viz.* matured green, half yellow and full yellow (matured fruit). The seeds were extracted from fruits and washed in water to get healthy and quality seeds. After washing in water to remove the mucilage, the seeds were dried in the shade under ventilated condition. The experiment was carried out in completely randomized block design and replicated four times. The seeds were treated with bavistin to prevent seed rot. Seed beds were made near nursery block. Each bed contains 100 seeds per treatment.

The treatments given are stated below:
T1: Seeds extracted from matured green fruits
T2: Seeds extracted from half yellow fruits
T3: Seeds extracted from full yellow (matured) fruits

Result and discussion

The result revealed that maximum seed germination percentage was obtained from seed extracted from half yellow stage of fruit maturity with germination percentage of 43.83 followed by seed extracted from full yellow stage of fruit maturity with germination percentage of 42.33 (Table 13). The lowest seed germination percentage was obtained from seed extracted at matured green stage (37.17 %).

Table 13: Effect of seed obtained from different stage of maturity on seed germination at NCRP in 2016/17 (2073/74)

Seed obtained from stage of maturity	Percentage of seed germination
Matured green	37.17 b
Half yellow	43.83 a
Full yellow	42.33 ab
Mean	**41.11**
P-value	****
CV %	**28.84**
$LSD_{(0.05)}$	**6.22**

3.3.4 Study on seed germination of trifoliate orange under different nursery raising environments in relation to sowing time

Environmental factors such as temperature, light, soil moisture and P^H are known to affect seed germination. Germination rate usually increases linearly with temperature at least within a well-defined range, and declines sharply at higher temperature. The improper agronomic management, such as, sowing at wrong time may cause low percentage of seed germination. The field environment at which the crop is grown and also seeds are harvested regulates the quality of seeds. Therefore, this research work was undertaken with a view to investigate the effect of sowing dates on seed germination of trifoliate orange.

Methodology

The experiment was carried out to study the response of different nursery raising environments and sowing dates for maximum seed germination of trifoliate orange at NCRP, Paripatle, Dhankuta in the fiscal year 2073/74. Trifoliate fruits were harvested from trifoliate orchard located at NCRP. The seeds were extracted from fruits and washed in water to get healthy and quality seeds. After washing in water to remove the mucilage, the seeds were dried in the shade under ventilated condition. The experiment was carried out in completely randomized block design and replicated four times. Three different raising environment *viz.*, NCRP method (Plastic tunnel with all sides closed), traditional method (no plastic tunnel) and Dailekh method (plastic tunnel with two end open) and four different dates of sowing *viz.*, Shrawan 30, Bhadra 12, Bhadra 22 and Asoj 2 were selected for study. The seeds were treated with bavistin to prevent seed rot.

Seed beds were made near nursery block. Each plot contains 100 seeds per treatment. The treatments given are stated below:

Treatement	**Raising environment**		**Date of sowing**
T1:	NCRP method	+	Shrawan 30
T2:	Traditional method	+	Shrawan 30
T3:	Dailekh method	+	Shrawan 30
T4:	NCRP method	+	Bhadra 12
T5:	Traditional method	+	Bhadra 12
T6:	Dailekh method	+	Bhadra 12
T7:	NCRP method	+	Bhadra 22
T8:	Traditional method	+	Bhadra 22
T9:	Dailekh method	+	Bhadra 22
T10:	NCRP method	+	Asoj 2
T11:	Traditional method	+	Asoj 2
T12:	Dailekh method	+	Asoj 2

Result and discussion

The relation between different raising environment and date of sowing was found statistically significant. It is evident from table 14 that seed germination was highest when seeds were sown on Bhadra 22 month with Dailekh method with germination percentage of 65.11 followed by Bhadra 22 with NCRP method with germination percentage of 62.78. The least seed germination was obtained when seeds were sown on Shrawan month with NCRP method (13.56 %) followed by Asoj month with traditional method (15.22 %).

Table 14: Relation between date of sowing and different raising environment conditions on seed germination at NCRP in 2016/17 (2073/74)

Treatment combination	Percentage of seedgermination
NCRP method and Shrawan 30	18.89 d
Traditional method and Shrawan 30	57.67 a
Dailekh method and Shrawan 30	59.89 a
NCRP method and Bhadra 12	13.56 d
Traditional method and Bhadra 12	31.89 bc
Dailekh method and Bhadra 12	42.44 b
NCRP method and Bhadra 22	62.78 a
Traditional method and Bhadra 22	43.11 b
Dailekh method and Bhadra 22	65.11 a
NCRP method and Asoj 2	61.89 a
Traditional method and Asoj 2	15.22 d
Dailekh method and Asoj 2	20.89 cd
Mean	**41.02**
P-value	****
CV %	**28.84**
$LSD_{(0.05)}$	**11.03**

Mandarin orchard declined due to root rot

Mandarin orchard recovered from root rot after drenching

Drenching with fungicides

Sowing of trifoliate seed in different environmental conditions

3.4 CITRUS DECLINE MANAGEMENT

3.4.1 Study on efficacy of different bio-chemical agents and fungicides for management of citrus root rot

The citrus decline is not a specific disease, but merely a term that denotes the wasting away the growth or fruit production and that may involve the ultimate death of the tree. It is rather unfortunate, that the various ailments of the citrus have been brought together under one ‘catch-all’ term decline, thus, resulting in beclouding the problem rather than illuminating it. The possible cause contributing to the decline syndrome are citrus greening, citrus tristeza virus, root rot including other diseases, insects, poor orchard management, unfavorable soil, climate and low quality planting material.

NCRP has generated several innovative technologies on integrated plant nutrient management, insect, pest and disease management, orchard management, etc. to revive declined orchard to healthy and productive one. Thus, this study was carried out on fiscal year 2073/74 to meet the following objective:

- To revive the declined mandarin orchard (caused by Phytophthora root rot and Fusarium root rot) to healthy and productive orchard.

Methodology

The declined mandarin orchard was initially identified and root sample of infected plant were collected and send to Khumaltar for diagnosing pathogen causing the root rot disease and was confirmed to be *Phytophthora* spp and *Fusarium* spp.

Eighteen infected trees were selected. Soil drenching was done with six treatments including two different bio-control agents, three fungicides and one control and was replicated three times. The treatments given to infected plant are listed below:

T1- Drenching with *Trichoderma viride* @ 10 gm/lt of water
T2- Drenching with Pseudomonas fluroscens @ 10 gm/lt of water
T3- Drenching with Copperoxychloride @ 4 gm/lt of water
T4- Drenching with 1% Bordeaux mixture
T5- Drenching with Carbendazim @ 2 gm/lt of water
T6- Control

The root of infected plant was exposed and infected roots were pruned. Drenching of roots and soil with above listed bio-control agent and fungicide were done and exposed area was filled with soil.

Beside above treatment, manure, fertilizer and micronutrients in soil FYM @ 30 kg + N 250 gm + P 125 gm + K 250 gm + Boric acid 10 gm + Zinc sulphate 75 gm + Copper sulphate 40 gm + manganese sulphate 25 gm + agri lime 75 gm per plant was applied. Nitrogen was applied in two equal split doses i.e. first as basal dose after harvest and second dose at the time of flowering.

Achievement

All the treated mandarin plants revive to healthy condition as the result of soil drenching irrespective type of bio-fungicides and fungicides. This technology will be disseminated to root rot infected mandarin orchards across the country.

3.5 Multi-locations (Collaborative) Trial

3.5.1 Coordinated Varietal Trial on Ginger

Introduction

The family Zingiberaceae comprises of five genera that are commercially important, namely *Amomum*, *Curcuma*, *Elettaria* and *Zingeber*. Ginger belongs to the gens *Zingeber* and turmeric to *Curcuma*. In both plant, the underground stem (rhizome) is commercial product. Zingiberaceous spices are known for their properties in the traditional systems of medicine in Asia. There are several pharmaceutical applications for these spices. Ginger contains about 1.5-2.5% volatile oil, namely Zingiberine that contributes the aroma. The oleoresin content varies from 4-10% known as gingerol that contributes to the taste and smell.

Methodology

Seven genotypes of ginger including 'Local Check' were obtained from National Ginger Research Program (NGRP), Salyan in 2016. They were included in CVT, and evaluated in the field of NCRP, Dhankuta with three replications in RCBD. Thirty tones of FYM/ha were incorporated into soil in the first week of May, 2016: 70 kg Nitrogen, 50 kg Phosphorus and 50 Kg Potassium/ha were recommended doses of fertilizer/ha. Full dose of phosphorus and half dose of potash were applied as basal dose prior to planting rhizome in the last week of May. Rhizomes were planted in the intra row spacing of 30 cm and inter-row spacing of 30 cm. Immediately after rhizome planting, dry forest leaves @ 16 tones/ha were applied as mulching. The whole recommended nitrogen dose was split into two doses: first at 30 days after planting and remaining half dose of nitrogen and half dose of potash were applied at 60 days after planting. Weeding was done twice: first in 45 days after rhizome planting and second in 70 days after rhizome planting. Earthing up was given in 140 days after rhizome planting. Fresh rhizomes were harvested in 232 days later than planting day. Experimental data *viz.*, plant height, number of tillers per clump, length of primary and secondary fingers, fresh rhizome yield and Dry Ginger Recovery (DGR %) were recorded.

Result and discussion

The result from table 15 reveals that plant height, number of tillers per clump, length of primary and secondary fingers and dry ginger recovery % were non-significant whereas fresh rhizome yield was found statistically significant.

Plant height

Plant height varied from 77.53 cm to 103.20 cm with the mean height of 90.22 cm (Table 15). The highest plant height was recorded from genotypes ZI 1027 (103.20 cm)

and ZI 1025 (101.53 cm). The lowest plant height was recorded from local genotype (77.53 cm) and ZI 1302 (82.93 cm).

Number of tillers per clump

The number of tillers per clump varied from 7.67 to 13.47 with the mean of 10.82 (Table 15). The highest number of tillers per clump was observed in genotypes ZI 1027 (13.47) and ZI 1025 (11.40). The lowest number of tillers per clump was recorded from local genotype (7.67) and KK1 (10.67).

Length of primary finger

The length of primary finger ranged from 4.81 cm to 5.32 cm with the mean value of 5.02 cm (Table 15). The highest length of primary fingers was recorded from genotypes ZI 1302 (5.32 cm) and ZI 1025 (5.23 cm). The smallest length of primary finger was recorded from genotype ZI 8502 (4.81 cm) and local genotype (4.89 cm).

Length of secondary finger

The length of secondary finger ranged from 7.56 cm to 9.30 cm with the average value of 8.39 cm (Table 15). The highest length of secondary finger was observed from genotypes ZI 1027 (9.30 cm) and KK1 (9.22). The lowest length of secondary finger was observed in local genotype (7.56 cm) and ZI 8502 (8.00 cm).

Fresh rhizome yield

The fresh rhizome yield ranged from 5.46 t/ha to 39.04 t/ha with the average yield of 23.32 t/ha (table 15). The highest fresh rhizome yield was obtained from genotypes ZI 1027 (39.04 t/ha) and KK1 (29.39 t/ha). The lowest fresh rhizome yield was obtained from genotypes ZI 8502 (5.46 t/ha) and ZI 1302 (16.55 t/ha).

Dry ginger recovery %

The dry ginger recovery % ranged from 19.00% to 20.00% with mean value of 19.50% (Table 15). The highest DGR % was recorded from genotypes ZI 1025 (20.00%), ZI 8502 (19.83%) and ZI 1007 (19.83%). The lowest DGR % was recorded from genotypes KK1 (19.00%), ZI 1302 (19.17%) and ZI 1027 (19.17%).

Table 15: Performance of seven genotypes of ginger tested under Coordinated Varietal Trial in the field of NCRP, Paripatle, Dhankuta in 2016

Genotypes	Plant height (cm)	No. of tillers per clump	Length of fingers (cm)		Fresh rhizome yield (t/ha)	DGR %
			Primary	Secondary		
ZI 8502	90.53	10.87	4.81	8.00	5.46	19.83
ZI 1302	82.93	10.73	5.32	8.48	16.55	19.17
ZI 1027	103.20	13.47	4.79	9.30	39.04	19.17
ZI 1025	101.53	11.40	5.23	8.10	23.06	20.00
ZI 1007	89.87	10.93	5.07	8.13	24.20	19.83
Local	77.53	7.67	4.89	7.56	25.26	19.50
KK 1	85.93	10.67	5.00	9.22	29.39	19.00
Mean	**90.22**	**10.82**	**5.02**	**8.39**	**23.32**	**19.50**
P-value	**NS**	**NS**	**NS**	**NS**	******	**NS**
$LSD_{(0.05)}$	**32.50**	**5.88**	**0.71**	**2.24**	**36.15**	**1.37**
CV %	**14.78**	**18.35**	**11.08**	**11.3**	**43.30**	**6.31**

3.5.2 Coordinated Farmers Field Trial on Turmeric

Introduction

The family Zingiberaceae comprises four or five genera that are commercially important, namely *Amomum*, *Curcuma*, *Elattaria* and *Zingeber*. Turmeric belongs to the genus *Curcuma*. In plant the underground stem (rhizome) is commercial product. It is a flowering plant, a perennial herb that measures about 40 inches in height and has white flowers. Zingiberaceous spices are known for their medicinal properties in the traditional systems of medicine in Asia. There are several pharmaceutical applications for these spices. Turmeric is valued for the yellow pigment curcumin (diferulolylmethane) which varies 4-8% in the dried rhizome. Curcumin in turn contains curcumin-1 (almost 94%), curcumin-11 (6%) and curcumin-111 (0.3%). Turmeric is used in cases of biliary disorders, intestinal disorders, anorexia, cough, diabetic wounds, hepatic disorder, pain, rheumatism and sinusitis, cancer, psoriasis and Alzhemer's disease (Anandaraj, 2009).

Methodology

Five genotypes of turmeric were obtained from National Ginger Research Program (NGRP), Salyan in 2015. They were included in CFFT, and evaluated in three farmers' field nearby NCRP, Dhankuta, considering one farmer as one replication. Thirty tones of FYM/ha were incorporated into soil in the first week of May, 2016: 30 Kg of Nitrogen, 30 Kg of Phosphorus and 69 Kg of Potash per hectare were recommended doses of fertilizer/ha. Full dose of phosphorus and half dose of potash were applied as basal dose prior to planting rhizome in the last week of May. Rhizomes were planted in the intra-row spacing of 30 cm and inter-row spacing of 30 cm. Immediately after rhizome planting, dry forest leaves @ 16 tones/ha were used as mulching. The whole

recommended nitrogen dose was split into two doses: first at 30 days after planting and remaining half dose of nitrogen and half dose of potash were applied at 60 days after planting. Weeding was done twice: first in 45 days and second in 70 days after rhizome planting. Earthing up was given in 140 days after rhizome planting. Fresh rhizomes were harvested in 240 days later than planting day. Experimental data *viz.*, Plant height, number of tillers per clump, length of primary and secondary fingers, fresh rhizome weight, weight of dry slice per kg sample, weight of dry powder per kg sample and Turmeric Powder Recovery (TPR %) were recorded.

Result and discussion

The result projected in table 16 illustrates that plant height and rhizome yield were statistically significant whereas number of tillers per clump, length of primary and secondary fingers were non-significant.

Plant height

The plant varied from 63.20 cm to 120.80 cm with mean plant height of 81.76 cm (Table 16). The highest plant height was recorded from genotype CI 0209 (120.80cm) and local genotype (91.30 cm). The lowest plant height was recorded from genotypes KK1 (63.20 cm) and CI 9803 (63.70 cm).

Number of tillers per clump

The number of tillers per clump varied from 1.10 to 1060 with mean value of 1.43 (Table 16). The highest number of tillers per clump was found in CI 0209 (1.60) and local genotype (1.60). The lowest number of tillers per clump was found in CI 9803 (1010) and KK1 (1.35).

Length of primary fingers

The length of primary fingers varied from 3.67 cm to 5.73 cm with mean value of 4.92 cm (Table 16). The highest length of primary finger was recorded from local genotype (5.73 cm) and CI 0209 (5.72 cm). The smallest length of primary finger was found with CI 9801 (3.67 cm) and CI 9803 (4.10 cm).

Length of secondary fingers

The length of secondary finger ranged from 5.48 cm to 8.63 cm with average value of 7.73 cm (Table 16). The highest length of secondary finger was found with KK1 (8.63 cm) and CI 9801 (8.48 cm). The smallest length of secondary finger was found with CI 0209 (5.48 cm) and CI 9803 (8.00 cm).

Rhizome yield

The rhizome yield varied from 5.65 t/ha to 43.10 t/ha with the average value of 17.07 t/ha (Table 16). The highest rhizome yield was recorded from genotypes CI 0209 (43.10 t/ha) and local genotype (15.32 t/ha). The lowest rhizome yield was obtained from genotypes CI 9803 (5.65 t/ha) and CI 9801 (9.75 t/ha).

Table 16: Performance of five genotypes of turmeric tested under Coordinated Farmers' Field Trial in Dhankuta in 2016

Geontypes	Plant height (cm)	No. of tillers per clump	Length of fingers (cm)		Rhizome yield (t/ha)
			Primary	Secondary	
CI 0209	120.80	1.60	5.72	5.48	43.10
CI 9801	69.80	1.50	3.67	8.48	9.75
CI 9803	63.70	1.10	4.10	8.00	5.65
KK 1	63.20	1.35	5.40	8.63	11.50
Local	91.30	1.60	5.73	8.06	15.32
Mean	**81.76**	**1.43**	**4.92**	7.73	**17.07**
P-value	******	**NS**	**NS**	**NS**	******
$LSD_{(0.05)}$	**96.75**	**0.83**	**3.81**	**5.05**	**58.75**
CV %	**7.72**	**13.08**	**20.47**	**19.48**	**28.43**

The result projected in table 17 illustrates that weight of dry slice per kg sample, weight of dry powder per kg sample and total powder recovery percentage was found non-significant.

Weight of dry slice per kg sample

The weight of dry slice per kg sample ranged from 0.19 kg to 0.20 kg with average value of 0.19 kg (table 17). The highest weight of dry slice was obtained from genotypes CI 9801 (0.20 kg) and KK1 (0.20 kg). The lowest weight of dry slice was obtained from genotypes CI 0209 (0.19 kg), CI 9803 (0.19 kg) and local genotype (0.19 kg).

Weight of dry powder per kg sample

The weight of dry powder per kg sample ranged from 0.18 kg to 0.20 kg with average value of 0.19 kg (table 17). The highest weight of dry powder was obtained from genotypes CI 9801 (0.20 kg) and KK1 (0.20 kg). The lowest weight of dry powder was obtained from CI 9803 (0.18 kg), CI 0209 (0.19 kg) and local genotype (0.19 kg).

TPR %

The total TPR % varied from 17.75 % to 19.25 % with average value of 18.55 % (table 17). The highest TPR % was found from genotypes CI 9801 (19.25 %) and KK1 (19.25 %). The lowest TPR % was found with genotypes CI 9803 (17.75 %), CI 0209 (18.25 %) and local genotype (18.25 %).

Table 17: Performance of five genotypes of turmeric tested under Coordinated Farmers' Field Trial in Dhankuta in 2016

Genotypes	Weight of dry slice (Kg)/ 1 Kg sample	Weight of dry powder (Kg)/ 1 Kg sample	TPR %
CI 0209	0.19	0.19	18.25
CI 9801	0.20	0.20	19.25
CI 9803	0.19	0.18	17.75
KK 1	0.20	0.20	19.25
Local	0.19	0.19	18.25
Mean	**0.19**	**0.19**	**18.55**
P-value	**NS**	**NS**	**NS**
$LSD_{(0.05)}$			**2.63**
CV %	**3.10**	**3.36**	**2.09**

4 PRODUCTION PROGRAM

NCRP has maintained production orchards of mandarin, sweet orange and acid lime for different research purposes. It spreads out in about 7 ha area. The popular local variety, which is known as Khoku local has occupied major portion of the production orchard followed by sweet orange variety Dhankuta local and different local genotypes of acid lime. This year, Rs.1.94 million revenue was collected from saplings, fruit production and other horticultural sources.

Besides, NCRP has a regular activity of sapling production of major varieties of mandarin, sweet orange and acid lime. In 2073-74, a total of 8,444 grafted saplings were produced and made available to the farmers. The figure showed the major demand of acid lime followed by mandarin. The demand of acid lime saplings was high from the farmers of terai districts. The detail of fruit and sampling production is given on the Table 18.

Table 18: Production of fruits and saplings during 2073/74

S.N.	Particulars	Quantity	Revenue (NPR) '000
1.	Mandarin saplings	499	26.50
2.	Sweet orange saplings	428	21.40
3.	Acid lime saplings	7426	371.30
4.	Kumquat saplings	30	1.80
5.	Rose saplings	61	24.40
6.	Mandarin fruits		1387.96
	Sub-total		**1833.36**
7.	Others horticultural sources		70.41
	Sub-total		**70.41**
8	Administrative		37.00
	Grand Total		**1940.77**

5 EXTENSION DISSEMINATION

Need of action research programs at problematic areas across the country.
Produce publication in Nepali language and provide to needy people.
Model orchard demonstration of promising technologies at different locations for larger impact. Make availability of adequate planting saplings of promising genotypes.

6 MARKETING

Need of strengthening the citrus marketing system avoiding middleman-controlled marketing system for getting higher benefit to the farmer.
Improvement on the post-harvest practices such as harvesting, packaging, and transportation with the technology adoption to minimize the losses.
Need of cooperative marketing.
Farmers to be trained with the knowledge for increasing bargaining power in market.
Develop the citrus farming as a business enterprise.

7 CALENDAR OF OPERATION

Based on research findings and field experiences, NCRP has developed a calendar of operation for citrus orchard management (Table 19).

Table 19: Calendar of operations adopted at NCRP, Paripatle for orchard management

Month	Operations
Baishak	New flush attracts insects like psylla, white black fly and leaf miner Irrigate the orchard and nursery bed at 8-12 days interval. Budding has to be done at the height of 9”-12” above the ground level. Integrated disease and insect management strategies should be adopted considering environmental protection and biodiversity conservation. Uproot the diseased and very old trees and prepare pits for new plantation. Note: spraying any sort of fungicide, antibiotic and insecticide must be discontinued during flowering period.
Jestha	Increase the frequency of irrigation from earlier schedule of 8-12 days to 5-7 days interval in case of absence of pre-monsoon showers. The most critical period is during heat spells. To be more accurate, check to moisture level 12” deep under trees to determine dryness and water accordingly. Keep water away from the trunk. Grafted/budded rootstock in winter months requires checking, thereafter, the tops of successfully intake grafting/budding are to be cut. Any fertilizer should be applied if there is sufficient moisture in soil. Recommended prophylactic measures need to be followed to the plants infected with *Phytophthora.* Make a drainage system in the orchard.

	Prepare the nursery bed for rootstock transplant. Prepare compost for next year.
Ashad	The trunk of citrus trees that are infected with fungal diseases need to be applied with Bordeaux paste as prophylactic measure against the collar rot and gummosis caused by *Phytophthora*. In case of water stagnation near the trunk of tree, 'V' shaped furrows are to dug in between the rows across the slope to drain out excess of water on the orchard. Incidence of citrus *Psylla* and leaf miner is common on new flushes. Recommended measures are to be followed by spraying insecticides at bud burst stage. Spray is to be repeated after 15 days in the event of noticeable infestation. Cankerous leaves and branches should be pruned and brunt and copper oxychloride should be sprayed before the onset of rainy season. Later than the onset of rainfall, copper oxychloride mixed with Streptocycline ought to be sprayed at monthly intervals. Spraying with sulfur containing fungicide to control powdery mildew. Transplant rootstocks for next year sapling. Distribution of healthy saplings to farmers.
Shrawan	Stagnated water should be disposed by providing trenches along with the slope. Weeding in citrus orchard. Doses of N, P and K fertilizers have to be applied depending upon the age of the trees in the later period of rainy season. If fruit drop is observed due to pathological and hormonal factors NAA or 2,4-D @ 8-15 ppm with urea @ 5 g and bavistin @1.5 g/ LW should be sprayed to reduce the intensity of fruit drop. Transplanting of rootstock seedling (Trifoliate) in main nursery block. Remove diseased, new suckers and dry branches. Spray insuf @ 2 g/l of water for the control of powdery mildew. If there is the incidence of fruit sucking moth, and puncturing, predisposing fruits to fungal infection which result in fruit drop. Light trap needs to be installed, and fallen fruits should be destroyed and buried in order to avoid its multiplication in soil.
Bhadra	Weeding in citrus orchards and nurseries. Application of Servo agro sprays mineral oil @ 15 ml/l of water to control scale insects. Management of citrus canker should be followed as per recommendation. Application of systemic insecticides for the control of green stink bug. Drenching of the root with 1% Bordeaux mixture infected by root rot disease. Harvesting of trifoliate fruit should be taken up at right stage of maturity. Sow the trifoliate rootstock seed in primary nursery for better growth of seedlings. Earthing up of basins to break the crust formed that facilitates aeration in

	root zone.
Ashoj	Basins should be kept ready for irrigation. New flush should be sprayed with insecticides against citrus psylla and leaf miner. Likewise, recommended dose of insecticide should be sprayed to control green stink bug. Weeding and mulching in the orchards. Stacking of heavily fruiting branches. Harvesting of citrange fruit should be taken up at right stage of maturity. Sow the citrange rootstock seed in primary nursery for better growth of seedlings. Apply Bordeaux paste after the withdrawal of monsoon. Collect fruit fly infected sweet orange fruits, and immerse them into big bucket full of water.
Kartik	Collect fruit fly infected sweet orange fruits and bury them into deep pits. Prepare new nursery bed and sow trifoliate seed for next year production. Excess leaf fall could be an indication of disease infestation. Suitable control measures are to be taken up. Harvesting of early maturing species of citrus fruits for rootstock should be taken up at right stage of maturity. Harvesting of early maturing varieties.
Mangsir	Harvesting of mid-season varieties. Grafting for sapling production.
Poush	Harvesting of mid-season varieties. Grafting for sapling production. Farm yard manure should be applied to facilitate decomposition. Its mobilization starts after 3-4 months.
Magh	Irrigate the orchard at 7-10 days intervals. Harvesting of late season varieties. Pruning and training should be carried out. Fertilizer application and Servo agro spray to control scale insects. If zinc deficiency symptoms are notices, apply zinc sulphate.
Falgun	Servo agro spray to control scale insects; fertilizer application. Foliar spray of micronutrients. Insecticides spray in nursery plants to control leaf miner. Irrigation in orchards and nursery. In the case of zinc deficiency symptoms, zinc sulphate is to be mixed with adequate quantity of farm yard manure, and then applied to the plants by spreading uniformly on the entire root zone.
Chaitra	Irrigate the orchard and nursery bed. Uproot the diseased and very old unproductive trees and prepare pits for new plantation.

8 INFORMATION DISSEMINATION

Information regarding citrus research programs and technologies was shared with the visitors that altogether 1,550 visitors made their presence in NCRP. The visitors were mainly from farmers group, cooperatives, extension officials, entrepreneurs, NGOs/INGOs officials and others. They were acquainted with the field knowledge and experience of citrus cultivation.

9 SERVICES

In fiscal year 2073/74, NCRP supplied 8,444 grafted saplings of different citrus species to the farmers. The grafted saplings made available to the farmers comprised of Khoku local mandarin, Okitsuwase unshu, Miyagawase unshu, two acid lime varieties; Sunkatagi-1 and Sunkagati-2. In addition, the scion source from the mother plant of mandarin and acid lime varieties were provided to the nearby nursery entrepreneurs in Dhankuta district.

10 BUDGET STATEMENT

Budget and expenditure of regular program as well as beruju of the program has been presented in Annex 4 and 5 respectively

11 MAJOR PROBLEMS

The major problems of citrus industry in Nepal are summarized as following:

a) Lack of variety diversity- short crop harvest period,
b) Small production scale,
c) Poor orchard management,
d) Lack of efficient irrigation,
e) Fruit drop due to entomological, pathological and hormonal factors.
f) Incidence of insects and different diseases.
g) Presence of hard pan.
h) Non-availability of disease free planting materials.
i) Acidic soil condition including zinc, calcium and magnesium deficiency in most of the citrus orchards particularly in mid-hills of west Nepal.
j) Macro and micro-nutrient deficiency.
k) No information about the nutrient content of citrus orchard.
l) Poor institutional mechanisms and coordination for marketing, and
m) Lack of entrepreneurship

Regarding management aspect, NCRP is lacking human resources for several years. Currently, a total of 17 staffs are working in the Program although there are 43 approved positions allocated by the NARC. Among the working staffs, only two scientists are there for research execution.

12 FUTURE STRATEGIES

At present, government of Nepal has recognized citrus sector as the national important and prioritized commodity. Because of appropriate geography and climate, citrus is widely grown throughout the mid hills from east to west across the country. In addition to, acid lime could be grown in upland condition of terai. Moreover, the demand of mandarin and acid lime in the domestic markets is escalating very high in recent years. Thus, it has an enormous potential to generate income and employment including nutrition to rural farmers in the country.

However, citrus industry is still in traditional level that needs to be transformed into commercial production. Therefore, NCRP has future strategies to address the problems of short production period of existing varieties, low productivity and production, inferior fruit quality, citrus decline due to disease and pests including management factors. Similarly, problems in institutional mechanism and coordination for marketing and entrepreneurship for this crop should be adequately dealt with by the research and development. Moreover, the research focus shall be on citrus based farming system utilizing available resources and socio-economic condition of the farmers.

Therefore, NCRP has prioritized following research areas for the upcoming years:

i) Virus indexing program should be made compulsory by law with bud wood certification program, and it should be followed timely across citrus growing areas.
ii) The quality planting materials free from pathogens and resistant to various insect pest and diseases ought to be made available to the citrus growers.
iii) The private nurseries should be inspected routinely since the uncertified nursery plants produced from bud wood of unknown mother tree decide the future of the orchard.
iv) Developing disease resistant rootstock as well as identifying new dwarfing rootstocks for high density planting.
v) Excessive use of fertilizers, chemical pesticides be checked and organic citrus farming should be encouraged especially with the judicious use of bio-fertilizers and bio-control of pests with bio-pesticides.
vi) Postharvest processing and value addition,
vii) Marketing and export business,
viii) Cost effective and eco-friendly production technologies,
ix) Integrated nutrient management,
x) Breeding new varieties for extended harvest period,
xi) Biological pest and disease management,
xii) Water use efficiency,
xiii) In-vitro technology for healthy propagation,
xiv) Citrus based farming system, and
xv) Socio-economic studies

ANNEX

Annex 1: Citrus genotypes maintained at the field gene-bank of NCRP, Dhankuta

S.N0	Accession no	Identification/common name	Source
	A. Kumquat (Citrus japonica):		
1	NCRP-105	Fortunella (oval)	Unknown
2	NCRP-106	Fortunella (rounded)	Unknown
3	NCRP-115	Fortunella (Indian Muntala)	Unknown
	B. Mandarin (C. reticulata):		
4	NCRP-01	Khoku Suntala	Khoku, Dhankuta
5	NCRP-02	Kinnow	Pakistan
6	NCRP-03	Frutrel early	Unknown
	C. *Mandarin (C. unshiu):*		
7	NCRP-04	Unshiu	JICA, Japan
8	NCRP-05	Miyagawawase- Unshiu	JICA, Japan
9	NCRP-06	Okitsuwase- Unshiu	JICA, Japan
10	NCRP-08	Pongan, Tangerine	ICIMOD
11	NCRP-09	Kamala	Dhankuta
12	NCRP-10	Baskharka local (Parbat)	LAC, Lumle
13	NCRP-11	Sikkime suntala	Tehrathum
14	NCRP-12	Calamandarin	Unknown
15	NCRP-80	Satsumawase	INRA-CIRAD, France
16	NCRP-81	Satsuma Mino	INRA-CIRAD, France
17	NCRP-82	Satsuma URSS	INRA-CIRAD, France
18	NCRP-88	Fortune	INRA-CIRAD, France
19	NCRP-89	Kara	INRA-CIRAD, France
20	NCRP-90	Nova	INRA-CIRAD, France
21	NCRP-91	Pixie	INRA-CIRAD, France
22	NCRP-92	Dancy	INRA-CIRAD, France
23	NCRP-93	Avana	INRA-CIRAD, France
24	NCRP-94	Page	INRA-CIRAD, France
25	NCRP 95	Satsuma Okitsu	INRA-CIRAD, France
26	NCRP-97	Clamentine Mandarine Hernandina	INRA-CIRAD, France
27	NCRP-98	Clamentine Mandarine Oroval	INRA-CIRAD, France
28	NCRP-99	Clamentine Mandarine Commune	INRA-CIRAD, France

29	NCRP-100	Clamentine Mandarine Marisol	INRA-CIRAD, France
30	NCRP-101	Clamentine Mandarine Nules	INRA-CIRAD, France
31	NCRP-112	Gorkhali Suntala	Gorkha, Nareswor
32	NCRP-114	Khoku muted mandarin	NCRP, Dhankuta

S.N0	***Accession no***	***Identification/common name***	***Source***
	Tangor		
33	NCRP 102	Ellendale	INRA_CIRAD, France
34	NCRP 103	Murkott	INRA_CIRAD, France
35	NCRP 72	Ortanique	INRA_CIRAD, France
36	NCRP-07	Tangor, Murkotte	JICA, Japan
	Tangelo		
37	NCRP 73	Minneola	INRA_CIRAD, France
38	NCRP 74	Oriando	INRA_CIRAD, France
39	NCRP 75	Seminole	INRA_CIRAD, France
	D. Sweet orange (C. sinensis):		
40	NCRP-13	Valencia late	ICAR, India
41	NCRP-14	Sevelle common	ICAR, India
42	NCRP-15	Navelencia	ICAR, India
43	NCRP 16	Malta Blood Red	ICAR, India
44	NCRP 17	Samauti	ICAR, India
45	NCRP 18	Masambi	ICAR, India
46	NCRP-19	Vanelle	ICAR, India
47	NCRP-20	Ruby	ICAR, India
48	NCRP 21	White Tanker	ICAR, India
49	NCRP-22	Washington novel	ICAR, India
50	NCRP 23	Hamlin	ICAR, India
51	NCRP 24	Pine Apple	ICAR, India
52	NCRP-25	Yashida navel	FDC, , Kirtipur
53	NCRP-26	Madam vanous	GRESCO, Kathmandu
54	NCRP-27	Delicious seedless	ICIMOD
55	NCRP-28	Skages Bonanja	ICIMOD
56	NCRP-29	Blood red	ICIMOD
57	NCRP-30	New Hall Navel	ICIMOD
58	NCRP-31	Succari	ICIMOD
59	NCRP-32	Meisheu-9	ICIMOD
60	NCRP 33	Dhankuta Local	Dhankuta
61	NCRP 34	LueGim Gong	ICAR, India

62	NCRP 83	Cara Cara Novel	INRACIRAD, France
63	NCRP 84	Lane Late	INRACIRAD, France
64	NCRP 85	Pine Apple	INRACIRAD, France
65	NCRP 86	Valencia Late	INRACIRAD, France
66	NCRP 87	Salustiana	INRACIRAD, France
67	NCRP 96	Tamango	INRACIRAD, France

S.N0	***Accession no***	***Identification/common name***	***Source***
	Grape Fruit		
68	NCRP 45	Shamber	ICIMOD
69	NCRP 76	Henderson	INRA_CIRAD, France
70	NCRP 77	Star Ruby	INRA_CIRAD, France
71	NCRP 78	Reed	INRA_CIRAD, France
72	NCRP 79	Pink Rubi	INRA_CIRAD, France
73	NCRP-44	Phultrac (Pumelo)	Vietnam
74	NCRP-43	Nam Roi (Pumelo)	Vietnam
75	NCRP-42	Phodiem (Pumelo)	Vietnam
	E. Acid lime (C. aurantifolia):		
76	NCRP-108	Khursanibari local	SHARP, Chitwan
77	NCRP-107	Tehrathum local	Tehrathum
78	NCRP-117	Baitadi local	Baitadi
79	NCRP-118	Salyan local	Rojwal Takura, Salyan
80	NCRP-119	Bhojpur local	Takshor, Bhojpur
81	NCRP-120	Parwat local	Lekhpant, Parwat
82	NCRP-60	Kaptangang lamo	Sunsari
83	NCRP-59	Kaptangang golo	Sunsari
84	NCRP 58	Krishnapur kagati	Bharatpur, Chitwan
85	NCRP-57	Krishnapur kagati	Bharatpur, Chitwan
86	NCRP-56	Banarasi Kagati	Biratnagar
87	NCRP-55	Madrasi Kagati	Biratnagar
88	NCRP 54	Banarasi Kagati	Biratnagar
89	NCRP-53	Panta-1	Chitwan
90	NCRP-52	Belepur	Morang
91	NCRP-51	Sundarpur	Morang
92	NCRP-50	IAAS Acc # 71 (5)	IAAS, Rampur
93	NCRP-49	IAAS Acc # 101 (3)	IAAS, Rampur

94	NCRP-48	IAAS Acc # 101 (2)	IAAS, Rampur
95	NCRP-47	IAAS Acc # 01 (17)	IAAS, Rampur
96	NCRP-46	IAAS Acc # 01 (25)	IAAS, Rampur
	E. Lemon		
97	NCRP 61	*Ureka lemon Unkwown*	Unknown
98	*NCRP 63*	*Hill Lemon*	Sunderpur Morang
99	*NCRP 64*	*Ureka lemon Lamcho lemon*	Sunderpur Morang
100	*NCRP 109*	*Thimura local*	SHARP Chitwan
101	*NCRP 110*	*Biratnagar Local*	SHARP Chitwan
102	*NCRP 111*	*Prembasti local*	SHARP Chitwan
S.N0	***Accession no***	***Identification/common name***	***Source***
	Rootstocks		
103	NCRP 65	Citrange C-35	INRA_CIRAD
104	NCRP 66	Citrange – Carrizo	INRA_CIRAD
105	NCRP 67	Poncirus– Pomeroy	INRA_CIRAD
106	NCRP 68	Flying Dragon	INRA_CIRAD
107	NCRP 69	Citrumelo 4475	INRA_CIRAD
108	NCRP 70	Volkameriana	INRA_CIRAD
109	NCRP 71	Rangapur lime Red	INRA_CIRAD
110	NCRP 113	Citrange old	Unknown
111	*NCRP 38*	*citrange*	Unknown
112	*NCRP 35*	*Citron*	Unknown
113	*NCRP 36*	*Trifoliate*	Unknown
114	*NCRP 37*	*Rangapur lime*	Unknown
115	*NCRP 39*	*Boxifolia*	Unknown
116	*NCRP 40*	*Rough lemon*	Unknown
117	*NCRP 116*	*Rough lemon*	Paripatle Dhankuta
118	NCRP-41	Hokse	Dhankuta
119	NCRP-62	Local Bimiro (Citron)	Belahara, Dhankuta
120	NCRP-104	Sweet lime Citrus limetta	Dhankuta

Annex 2: Human Resource Allocation

Designation	Approved	Fulfilled	Vacant
1. Chief Scientist (S.5) – Soil	1	-	1
2. Senior Scientist (S.4)- Horticulture	1	1	-
3. Senior Scientist (S.3)- Horticulture	2	-	2
4. Senior Scientist (S.3)- Plant pathology	1	-	1
5. Scientist (S.1) - Soil	1	-	1
6. Scientist (S.1) - Plant breeding (Tissue culture)	1	-	1
7. Scientist (S.1) - Entomology	1	-	1
8. Scientist (S.1) - Plant Pathology	1	1	-
9. Senior Technical Officer (T.8) – Pomology	1	0	1
10. Senior Technical Officer (T.7) – Pomology	1	1	-
11. Technical Officer (T.6) - Pomology	3	1	2
12. Senior Technician (T.5)	2	-	2
13. Technician (T.4)	5	3	2
14. Technician (5^{th}.level)	17	11	6
15. Admin officer (A6)	1	1	-
16. Account officer (A6)	1	1	0
17. Computer operator (T5)	1	-	1
18. Administrative Assistant (A5)	1	-	1
19. Driver (4^{th}. level)	1	1	-
Total	43	21	22

Annex 3: Human Resource of NCRP in 2073/74

Name	Position	Qualification	Working area & remarks
1. Tul Bahadur Pun	Coordinator (S.4)	M. Sc (Hort.)	Coordinator and Fruits and vegetables
2. Dhana Bahadur Gharti	Coordinator (S.4)	M. Sc (Plant patho.)	Coordinator and Fruits and vegetables
3. Roshan Pakka	Scientist (S. 1)	M. Sc. (Plant Patho.)	Plant Pathology
4. Pradeep Karki	Tech. Officer (T.7)	M. Sc. (Hort.)	Support in research and production
5. ParsuramYadav	Tech.Officer (T.6)	Bachelors' degree	Support in research and production
6. Gopal Raj Shrestha	Admin. Officer (A.6)	I.A.	Administration and store
7. Basupasa Hangsarumba	Account Officer (A.6)	Bachelors' degree	Account section
8. Nar Bahadur	Technician	Literate	Support in research and

Name	Position	Qualification	Working area & remarks
Tamang	(T.4)		production
9. Prem Narayan Yadav	Technician (T.4)	B.Sc. Ag.	Support in research and production
10. Damali Sherpa	Technician (T.4)	JTA training	Support in research and production
11. Ram Awatar Mahato	Technician (T.4)	JTA	Support in research and production
12. Amar Bahadur Shrestha	TS- Fifth	Literate	Support in research and production
13. Jagat Bahadur Karki	TS- Fifth	Literate	Support in administration
14. Thir Bahadur Ale	TS- Fifth	Literate	Support in research and production
15. Tej Bahadur Darji	TS- Fifth	Literate	Support in research and production
16. Man BahadurTamang	TS- Fifth	Literate	Support in research and production
17. Hem BahadurDahal	TS- Fifth	Literate	Support in research and production
18. Tara Nath Khatri	Heavy driver-Fifth	S.L.C.	Driver
19. Sita Devi Dahal Pokhrel	TS-First	Literate	Support in research and production
20. Laxmi Bhattarai	TS-First	Literate	Support in research and production
21. Kashi Nath Subedi	TS-First	Literate	Support in research and production
22. Dhan Kumar Rai	TS-First	Literate	Support in research and production
23. Tetri Devi Shah	TS-First	Literate	Support in administration
24. Tek Bahadur Magar	TS-First	Literate	Support in research and production

Annex 4: Regular Annual Budget and Expenditure in 2073/74

Budget Code	Budget Heads	Annual Budget	Budget Released	Budget Expenditure	Balance
	Operational Expenses	**2,10,32,000.00**	**2,10,32,000.00**	**2,04,34,398.96**	**5,97,601.04**
21111	Staff Salary	68,00,000.00	68,00,000.00	67,80,488.50	**19,511.50**
21112	Local Allowances	2,06,000.00	2,06,000.00	1,82,027.00	23,973.00
21113	Dearness Allowances	25,2000.00	2,52,000.00	2,27,503.00	24,497.00
21119	Other Allowances	50,000.00	50,000.00	49,900.00	100.00
21121	Uniform	1,58,000.00	1,58,000.00	1,35,000.00	23,000.00
22111	Water and Electricity Expenses	7,10,000.00	7,10,000.00	6,93,276.50	16,723.50
22112	Communication Expenses	1,26,000.00	1,26,000.00	94,563.00	31,437.00
22211	Fuel	5,55,000.00	5,55,000.00	4,73,576.14	81,423.86
22212	Operational and Repair Expenses	9,50,000.00	9,50,000.00	948,957.25	1,042.75
22213	Insurance	51,000.00	51,000.00	42,312.00	8,688.00
22311	Office related expenses	5,00,000.00	5,00,000.00	4,83,722.00	16,278.00
22314	Fuel for Other Purposes	99,000.00	99,000.00	25,302.29	73,697.71
22321	Repair/Maintenance of Public Assets	6,00,000.00	6,00,000.00	5,99,967.00	33.00
22521	Production Material Service	83,00,000.00	83,00,000.00	80,58,854.78	2,41,145.22
22612	Travel Expenses	16,00,000.00	16,00,000.00	15,65,284.50	34,715.50
22711	Miscellaneous Expenses	75,000	75,000	73,665.00	1,335.00
	Capital Expenses	**63,74,000.00**	**63,74,000.00**	**63,52,192.36**	**21,807.64**
29221	Building Construction	10,50,000.00	10,50,000.00	10,48,716.40	1,283.60
29231	Capital Improvement - Building	18,99,000.00	18,99,000.00	18,91,828.21	7,171.79
29311	Furniture and Fixtures	4,10,000.00	4,10,000.00	4,09,986.60	13.40
29511	Machinery Equipment	4,15,000.00	4,15,000.00	4,14,532.90	467.10
29611	Public Construction	26,00,000.00	26,00,000.00	25,87,128.25	12,871.75
	Grand Total	**2,74,06,000.00**	**2,74,06,000.00**	**2,67,86,591.32**	**6,19,408.68**

Annex 5: Beruju Status of Fiscal Year 2073/74

Beruju	Amount	Remarks
Beruju till last year (2072/73)	0.00	
Beruju in FY 2073/74	0.00	
Beruju cleared in this FY (2073/74)	0.00	
Remaining beruju	0.00	