NARC Publication Serial No. 0036-2013/14

ANNUAL REPORT

2069/70 (2012/13)

NEPAL AGRICULTURAL RESEARCH COUNCIL
NATIONAL POTATO RESEARCH PROGRAMME
Khumaltar, Lalitpur, Nepal

2013

Comparison of Janak Dev with new late blight resistant clones
CIP 393280.57 and PRP 266264.15

Seed multiplication of late blight resistant clone PRP 35861.2
in Shardanagar, Chitwan

Annual Report

2069/70 (2012/13)

Nepal Agricultural Research Council

National Potato Research Programme

Khumaltar, Lalitpur, Nepal

2013

National Potato Research Programme (NPRP)

Nepal Agricultural Research Council (NARC)

Khumaltar, Lalitpur, Nepal

Telephone : +977-1-5522114

Fax : +977-1-5538005

Email : prp@narc.gov.np

URL : http://www.narc.gov.np

Editors: Dr. BP Luitel and Mr. BM Sakha

Citation:

NPRP, 2013. Annual Report 2069/70 (2012/13). (Eds. Dr. BP Luitel and Mr. BM Sakha). National Potato Research Programme, NARC, Khumaltar, Lalitpur, Nepal.

Cover Page Photo:

Vegetative growth (Top) and pre-basic seed potato production (Bottom) under hydroponic system in NPRP.

FOREWORD

National Potato Research Programme (NPRP) gratefully acknowledges for the contributions on potato research from NARC disciplinary Divisions, Regional Agriculture Research Stations, Agriculture Research Stations and National Potato Development Programme (NPDP) for providing farmers feed back with respect to the adoption of potato varieties and the technologies developed by NPRP.

NPRP is thankful to the International Potato Center (CIP), Lima, Peru and its Regional Office New Delhi, India for providing potato clones as per demand and participating in nutrition potato variety development through ADA project. NPRP is thankful to collaborative farmers, who participated in the on-farm research, for late blight resistant variety selection, high yielding and nutritious variety selection and the District Agriculture Development Offices in the concerned outreach stations.

Dr. BP Luitel, Scientist, and Mr. BM Sakha, Senior Scientists are highly acknowledged for their tedious efforts compiling and editing this report. I would like to thank other Senior Scientists Mr. IP Gautam, Dr. SP Dhital and Dr. BB Khatri for bringing this Annual Report in this form and all other technical and administrative staffs of NPRP for their good cooperation and hard works.

Mr. Buddhi Prakash Sharma
Coordinator
National Potato Research Programme
Khumaltar, Lalitpur

ABBREVIATIONS

ARS	Agriculture Research Station
BS	Basic seed
CFFT	Coordinated Farmer's Field Trial
CIP	International Potato Center
CVT	Coordinated Varietal Trial
DADO	District Agriculture Development Office
DAS-ELISA	Double Antibody Sandwiched - Enzyme Linked Immuno Sorbant Assay
F_1	First generation
F_1C_1	First clonal generation of TPS
FAT	Farmer's Acceptance Test
FYM	Farmyard manure
GC	Ground coverage
HPS	Hybrid Potato Seed
HYV	High yielding variety
IDM	Integrated disease management
IET	Initial Evaluation Trial
LSD	Least significant difference
NGOs	Non-government organizations
NPDP	National Potato Development Programme
NPRP	National Potato Research Programme
NS	Non-significant
OFSP	Orange fleshed sweet potato
PACT	Project for Agriculture Commercialization and Trade
PBS	Pre-basic seed
PLRV	Potato Leaf Roll Virus
PTM	Potato tuber moth
PVA	Potato Virus A
PVE	Participatory Varietal Evaluation
PVM	Potato Virus M
PVS	Potato Virus S
PVS	Participatory Varietal Selection
PVX	Potato Virus X
PVY	Potato Virus Y
RARS	Regional Agriculture Research Station
TPS	True Potato Seed
VDC	Village Development Committee

TABLE OF CONTENTS

List of Tables

List of Figures

List of Annexes

प्रमुख सार संक्षेप

१.० आलु अनुसन्धान

१.१ आलुको जातिय उत्थान अध्ययन परिक्षण

- ☐ आ.व. २०६९।७० मा आलुका नयाँ जात संकलन, पुराना जातहरुको संरक्षण एवं विभिन्न नयाँ जातहरुको बीउ बृद्धि कार्य राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम, खुमलटारको हात्तीवन अनुसन्धान फार्ममा र कृषि अनुसन्धान केन्द्र (बागवानी) मालेपाटन, कास्कीमा गरियो । प्रारम्भिक मूल्यांकन परिक्षण, समन्वयात्मक जातीय परिक्षण र कृषकको खेतबारीमा गरिने जातीय परिक्षणहरु पनि राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम, खुमलटार, कृषि अनुसन्धान केन्द्र (बागवानी) मालेपाटन, पोखरा, कृषि अनुसन्धान केन्द्र (बागवानी) जुम्ला, कृषि अनुसन्धान केन्द्र, पाखीबास, क्षेत्रीय कृषि अनुसन्धान केन्द्र, खजुरा, डोटी र तरहरामा सम्पन्न गरियो ।
- ☐ जातीय अनुसन्धानको तुलनात्मक अध्ययनबाट विश्लेषण गर्दा गतबर्षमा PRP 25861.1, CIP393385.39 र CIP385499.11 जातहरु पहाडी भेगमा राम्रो उत्पादन दिने, डढुवा रोग सहन सक्ने एवं कृषकलाई मनपरेको पाइयो भने PRP85861.11 र PRP85861.8 चाहि तराईको आवहवामा बढी उत्पादनशील, डढुवा रोग सहन सक्ने एवं कृषकलाई मनपरेको पाइयो ।

१.२ टि.पि.एस. जातीय अध्ययन परिक्षण

- ☐ आ.व. २०६९/७० मा कृषकको खेतबारीमा गरिएको टि.पि.एस. परिवारको दोश्रो पुस्ताहरुको मुल्याङ्कन परिक्षणको आँकडा अनुसार टि.पि.एस परिवार LT-8 xTPS-67 ले चितवनको शारदानगरमा सबभन्दा बढी उत्पादन (१५.३७ के.जी/७.२ वर्गमिटर) दिएको पाइयो । त्यस्तै मध्य पहाडको काभ्रेपलाञ्चोक जिल्लाको कुशादेवी गा.वि.स.मा गरिएको परिक्षण अनुसार टि.पि.एस परिवार LT-8xTPS-13 ले सबभन्दा बढी आलु उत्पादन (२२.६७ के.जी/७.२ वर्गमिटर) गरेको पाइयो ।
- ☐ आ.व. २०६९/७० मा नै गरिएको टि.पि.एस. परिवारको पहिलो पुस्ताहरुको मुल्याङ्कन परिक्षणको आँकडा अनुसार चेक जात कुफ्रिज्योतीले खुमलटारमा सबभन्दा बढी उत्पादन (२२.४३ के.जी) र LT-8xTPS-67 ले सबभन्दा बढी आलुदाना संख्या (५८१) प्रति ७.२ वर्गमिटरमा उत्पादन गरेको पाइयो । त्यस्तै नेपालगञ्जमा गरिएको परिक्षण अनुसार चेक जातहरु क्रमशः कुफ्री सिन्धुरी र पेरीकोलीले सबभन्दा बढी दाना संख्या (४७६) र बढी उत्पादन (२० के.जी) प्रति ७.२ वर्गमिटरमा गरेको पाइयो ।

१.३ आलुबालीमा बद्लिंदो हावापानीको असर अध्ययन परिक्षण

- आ.व. २०६९/७० मा देशका विभिन्न भागमा कृषि वातावरण अनुसन्धान महाशाखा, खुमलटार संगको समन्वय र परिषद् अन्तर्गतका विभिन्न कार्यक्रम तथा केन्द्रहरुको सहयोगमा यस आयोजना अन्तर्गत बढि उत्पादन दिने उन्नत तथा स्थानिय जातहरुको संकलन, सम्वर्धन तथा बीउ बृद्धि र कृषकको सहभागितामा आलुका जातीय मुल्यांकन परिक्षण समेत दुईवटा कृयाकलापहरु संचालन गरिए । कृयाकलाप १ अन्तर्गत बीउ बृद्धिवाट उत्पादित ६५८ किलो बीउ बालाजु स्थित शित भण्डार गृहमा भण्डारण गरीएको छ, उक्त बीउ अर्को बर्ष अनुसन्धान परिक्षणमा प्रयोग गरिनेछ ।
- दोश्रो कृयाकलाप अन्तर्गतका परिक्षणहरु कृषि अनुसन्धान केन्द्र, बेलाचापी, धनुषा, क्षेत्रिय कृषि अनुसन्धान केन्द्र, परवानीपुर, बारा, क्षेत्रिय कृषि अनुसन्धान केन्द्र भैरहवा, क्षेत्रिय कृषि अनुसन्धान केन्द्र लुम्ले र कृषकको खेतवारी जुम्लामा संचालित थिए । उक्त परिक्षणहरुबाट उपलब्ध आँकडा अनुसार पहाडका लागि उन्मोचनोन्मुख जात L235-4 बेलाचापी, धनुषामा, PRP-35861.18 परवानीपुर बारामा, PRP85861.11 भैरहवामा , PRP225861.5 लुम्लेमा र CIP385499.11 नामक जातले जुम्लाको हावापानीमा पनि राम्रो उत्पादन दिएर उत्कृष्ट देखिए । यो परिक्षणले पहाडका लागि भनेर सिफारिस गरिएका आलुका जातहरु तराइको अवस्थामा पनि र तराइका लागि सिफारिस गरिएका जातहरु पहाडमा पनि राम्रो उत्पादन दिन सक्छन् । तर यसका पछाडीका कारणहरु के के हुन् सक्छन्, यसको थप अध्ययन अनुसन्धान गरिनुपर्ने आवश्यकता देखिन्छ ।

१.४ प्रशोधनको लागि आलुको जातिय अध्ययन परिक्षण

- काठमाडौ उपत्यका र सो सरह हावापानी भएको क्षेत्रमा चिप्स प्रशोधनको लागि मुख्य मौसममा आलुका जातहरु पि.आर. पी: २५८६१.१, खुमल सेतो -१ र एल २३५.४ उपयक्त देखिए । सो समयमा कुफ्रिज्योती जातले बढी उत्पादन दिएतापनि दानामा सुख्खा पदार्थ कम देखिएकाले प्रशोधनको लागि त्यती उपयुक्त देखिएन ।
- साधारण भण्डारण (२६.१ ± १° से. र ६२-८२ % सापेक्षिक आर्दता) कोठामा अध्याँरोमा १२० दिन सम्म भण्डारण गर्दा आलुका जात यागाना (१२.३३%) , एल २३५.४ (१४.७०%), कुफ्रिज्योती (१६.०७%) र खुमल सेतो -१ (१६.४६%)मा तौलमा कम ह्रास आाएको पाइयो जबकी ह्रासको मात्रा सबभन्दा बढी (२४.३५%) वि.यस.यू.पि. ओ-३ मा पाईयो ।
- शित भण्डारणमा १२० दिन सम्म भण्डारण गरी झिकेका आलुलाई १५ दिनसम्म साधारण कोठामा फिंजाउँदा कुफ्रिज्योती र कुफ्रि चिप्सोना-२ मा क्रमशः ८.८६% र ८.१७% तौलमा ह्रास आएको थियो भने सबभन्दा कम ह्रास (५.२५%) खुमल सेतो-१

मा पाईयो । शित भण्डारण गरिएका आलुमा परिवर्तनशिल चिनीको मात्रा बढी भएकाले कुनै पनि जात चिप्स बनाउनको लागि उपयुक्त देखिएनन् ।

- मध्य पहाड र उच्च पहाडमा आलुलाई साधारण कोठामा भण्डारण गर्नुभन्दा पहिले र भण्डारण गरेको ४५ दिनमा सि.आई.पि.सी. (उर्जा) भन्ने औषधि ४० मि.ली. प्रतिलिटर मिथेनोलमा मिसाई प्रतिटन आलुमा उपचार गर्दा १२० दिन सम्म टुसा आउन रोक्ने र कम क्षति हुने देखिएयो ।
- एल २३५.४ जातलाई काठमाडौमा विभिन्न दूरीमा लगाउँदा प्रशोधनयोग्य दाना र कुल उत्पादनमा खासै फरक पाईएन तर चितवनमा गरिएको प्रमाणिकरणको नतिजा अनुसार प्रशोधनयोग्य दानाको उत्पादनमा फरक नदेखिएतापनि कुल उत्पादनको हिसाबले लाईन-लाईन दूरी ६० से.मी. र बोट-बोट दूरी २५-३० से.मि. नै बढी उपयुक्त देखियो ।
- बिभिन्न ७ जातको प्रमाणिकरण नतिजा अनुसार काठमाडौको लागि कुफ्रिज्योती र एल-२३५.४ राम्रा देखिए भने चितवनमा उत्पादनमा खासै अन्तर नदेखिएता पनि दाना रातो भएको कारण कृषकहरुले पि.आर.पि. २५८६१.१ जात बढी रुचाएको पाइयो ।

१.५ बीउ आलु अध्ययन परिक्षण

- आलुका विभिन्न जातहरु प्रयोगशालाभित्र लामो अवधि सम्म सरंक्षण गर्नको लागि प्रयोग गरिएका प्लान्ट ग्रोथ रिटारडेन्टसको असर चेक भन्दा राम्रो पाइयो । मालिक हाइड्राजाइड (८ पिपीएम) को असर विरुवाको बृद्धि रोक्न सबभन्दा राम्रो पाइयो अनी त्यसपछि ए.बी.ए. (५ पीपीएम) को असर पाइयो ।
- हाइड्रोपोनीक प्रविधिद्धारा आलुको पूर्व-मूलबीउ उत्पादन गर्दा विरुवको उचाई र आलुको दाना अन्य परम्परागत प्रविधी भन्दा सन्तोषजनक पाइयो । जसअनुसार जनकदेव जातले सबभन्दा बढी दाना संख्या (८१) हाइड्रोपानीक प्रविधीमा फलेको र खुमल सेतोले १९ दाना माटोमा फलेको पाइयो । समग्रमा परम्परागत प्रविधिमा लगाइएको विरुवाले भन्दा हाइड्रोपोनीक (पानी) मा लगाएका विरुवाबाट बढी दाना र उत्पादन गरेको पाइयो ।
- परवानीपुर र हात्तिवन फार्ममा संचालन गरको पि.बी.एस. आलुको गुणस्तर ह्रास अध्ययन परिक्षण अनुसार आलुमा लाग्ने विभिन्न बिषाणु (भाइरस) को असर दुबै खेतबारी तथा प्रयोगशालमा खासै उल्लेखनीय फरक पाइएन । परिक्षण गरिएको नमुनामा खासै आलुमा लाग्ने ६ प्रकारका बिषाणुको असर प्रभावकारी नपाइएपनी, बिषाणुको प्रभाव पार्ने स्तर भने फरक फरक पाइयो ।
- देशका विभिन्न अनुसन्धान केन्द्रहरुबाट आलुका नमूना संकलन तथा बिउ आलुको बारेमा केही जानकारी हासिल गर्ने उद्देश्यले सर्भे गरिएको थियो । जस अनुसार

आलुको पुस्ताहरुलाई क्रमवद्ध नगरेको पाइयो र स्थानीय जातहरुलाई बढी भाइरस रोगले आक्रमण गरेको कुरा सर्भे अनुसार अवगत भयो ।

- रोजीता जातलाई भाइरसमुक्त गर्नको लागि प्रयोगशालामा पठाइएको छ र साथै अन्य तीन आलुको नमुना पनी उक्त कार्यको लागि प्राप्त भएका छन् ।

१.६ पौष्टिक तत्व बढी भएका आलुका जातहरुमा अध्ययन परिक्षण

- यो ADA/CIP बाट आर्थिक सहायता प्राप्त तीनबर्षे आयोजना हो । यस आयोजनामा उत्पादनमा स्थायित्व र पौष्टिक तत्व बढि भएका आलुका जातहरुको छनौट कृषक प्राविधिक कार्य प्रसार संग सम्बन्धित सबै निकायहरुको संलग्नता रहन्छ । आ.व. २०६९/७० मा यस आयोजना अन्तर्गत जुम्लाको कृषि अनुसन्धान केन्द्र (बागवानी) राजिकोट र पटमारा गा.वि.स.मा लि-वर्ड नामक गैरसरकारी संस्था र मध्यमाञ्चलको सिन्धुपाल्चोक जिल्ला स्थित न्युक्लियस बीउ आलु उत्पादन केन्द्र, निगाले र दोलखा जिल्लामा पर्ने खरिदुङ्गा र निगाले क्षेत्रमा पर्ने कृषकको खेतबारीमा राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम खुमलटारले पौष्टिक तत्व बढी भएका आलुका जातहरुको जातिय छनौट परिक्षणहरु संचालन गरेको थियो । उक्त परिक्षणहरुमा जातीय छनौट प्रकृयालाई प्रभावकारी बनाउन र थोरै समयमा पनि आलुका जातहरु छनौट गर्न सकिने उदेश्यका लागि रोप्नुभन्दा अगाडी, फुल खेल्ने समयमा र खनाईको समयमा समेत गरी ३ पटक आलु उत्पादक कृषक, परिषद अन्तर्गतका वैज्ञानिक र प्राविधिक अधिकृतहरु र आलुबालीमा संलग्न कृषि प्रसारकर्ताहरुको सहभागितामा आलुको जातिय छनौट तालिम २ देखि ३ दिन सम्म दिइएको थियो ।
- निगाले फार्ममा मातृ परिक्षणमा रोपिएका विभिन्न १५ जातहरु मध्ये CIP395112.32, CIP395017.229 र CIP393073.179 नामक जातहरु र कृषकको खेतबारीमा परिक्षण गरिएका १५ जातहरु मध्ये CIP 395112.32 र स्थानिय जात रोजिटा नामक जात प्रथम बर्षको परिक्षणमा राम्रा देखिए । यी जातहरुको बोटको अवस्था डढुवा रोग सहन सक्ने क्षमता र उत्पादनलाई ध्यानमा राख्दा यिनै उत्कृष्ठ जातहरुको आवश्यक बीउ वृद्धि गरी बीउको उपलब्धताको आधारमा बढि स्थानहरुमा आगामी वर्ष परिक्षण गरिनेछ ।

१.७ आलुबालीमा लाग्ने डढुवारोग सम्बन्धि अध्ययन परिक्षण

- हात्तीवन फार्म, ललितपुरमा गरिएको आलुको डढुवा रोग अवरोधी प्रारम्भिक मुल्यांकन परिक्षणमा समाविष्ट ४६ आलुका जातहरु मध्ये धेरैजसो जातहरु डढुवा रोग अवरोधी पाईयो । यी जातहरु मध्ये कुफ्रिज्योती डढुवा रोग सहनै नसक्ने र सिआईपी ३९४०५०.११०, सिआईपी ३८५४९९.११ र पीआरपी २२६५६७.२ मध्यम रुपले डढुवा रोग सहन सक्ने, पीआरपी २५८६१.१, पीआरपी ०१६५६७.१२, सिआईपी ३९३०७३.१७९, सिआईपी ३९३६१७.१ र सिआईपी ३९५११२.३२ डढुवा रोग अवरोधी र बाँकी जातहरु अत्याधिक अवरोधी पाईयो । यी जातहरुमा अत्याधिक उत्पादन क्षमता (३० देखि ५६ टन/ हेक्टर) भएको पनि पाईयो ।
- उच्च पहाडी क्षेत्रमा अवस्थित न्युक्लियस बीउ आलु केन्द्र, निगाले, सिन्धुपाल्चोकमा गरिएको आलुको डढुवा रोग अवरोधी जातीय छनोट परिक्षणमा आलुका २७ जातहरुमध्ये पीआरपी ८५८६१.११, एलबीआर ४०, सिआईपी ३८४३२१.१५, सिआईपी ३९२६५७.८, पीआरपी २६६२६४.०१, पीआरपी २५८६१.१, पीआरपी ८५८६१.११ र पीआरपी २७६२६४.०१ डढुवा रोग अवरोधी पाईयो ।
- जनकदेव, एल २३५.४ र सिआईपि ३८९७४६.२ जस्ता मध्यम डढुवारोग अवरोधि आलुका जातहरुमा सेक्टीन विषादी १.५ग्राम/लि. पानीका दरले ९ दिनको अन्तरमा बोट भिज्ने गरी ४ पटक छरिएमा डढुवारोग नियन्त्रण भई क्रमसः १९, २२ र २७ टन/हे. आलुको उल्लेख्य उत्पादन गर्न उपयोगी पाईयो । मेटाल्याक्सिलयुक्त विषादीको विकल्पमा यो विषादीको प्रयोगबाट तुलनात्मक हिसाबले डढुवारोगको राम्रो व्यवस्थापन गर्न सकिने भएको छ ।
- सिन्धुपाल्चोकको निगालेमा ऐजेरु रोग अवरोधी परिक्षणमा समाविष्ट २६ जातहरुमध्ये उन्मोचन गरिएका जातहरु जनकदेव र कुफ्रिज्योतीको साथै बीएसयुपीओ-३ र सिआईपी ३९२६६१.१८ ऐजेरु रोग अवरोधी पाइयो । नौ जातहरु क्रमशः सिआईपी ३९३०७७.५४, पीआरपी २२५८६१.२, पीआरपी ८५८६१.८, पीआरपी २६६२६४.१५, सिआईपी ३९४०५०.११०, सिआईपी ३९३२८०.५७, पीआरपी ८५८६१.११, पीआरपी २५८६१.१ र सिआईपी ३९३३८५.३९ सामान्य अवरोधी पाईयो । स्थानीय जात रोजिटामा सबैभन्दा बढी (९३ %) ऐजेरु रोगको संक्रमणता देखियो ।
- चितवनको शारदानगरमा गरिएको धुले दाद व्यवस्थापन परिक्षणमा ८ % युथेन एम-४५ को घोलमा ३० मिनेट डुबाई बीउ उपचार गरि लगाईएको प्लटमा सबैभन्दा बढी रोग नियन्त्रण (५७ %) भएको पाईयो । ४ % एन्ट्राकोल को घोलमा डुबाई बीउ उपचार गर्दा ५२% र ब्लिचिङ्ग पाउडर २ % को घोलमा बीउ उपचार गर्नुका साथै २५ के जी प्रति हेक्टरका दरले माटो उपचार गर्दा ४६% रोग नियन्त्रण भएको पाईयो । धुले दादको जीवाणुबाट संक्रमित भईसकेको माटोमा स्वस्थ बीउ आलु लगाउँदा केवल ४४% मात्र रोग नियन्त्रण भएको पाईयो ।

- विभिन्न हावापानीमा कृषकको सहभागितामा संचालीत डढुवा रोग अवरोधी जात छनौट परिक्षणमा संलग्न जातहरुमध्ये पीआरपी २६६२६४.१५ चितवनमा (३२.६ टन/ हेक्टर) र बर्दियामा (३५.२ टन/ हेकटर) सबैभन्दा बढी उत्पादन भएको पाईयो । कास्कीमा भने उन्मोचनका लागि सिफारिस गरिएको जात सिआईपी ३८९७४६.२ बाट सबैभन्दा बढी (४६ टन/ हेक्टर) उत्पादन भएको पाईयो । बर्षौ देखिका पुराना जातहरु जनकदेव तथा एमएस४२.३ उत्पादनको तुलनामा नयाँ जातहरुको उत्पादन अत्याधिक पाईयो । यो परिक्षणमा बाली अवधि भर कुनैपनि स्थानमा कुनै पनि विषादी प्रयोग गरिएको थिएन ।

३.० सखरखण्ड अनुसन्धान

३.१ सखरखण्डको जातिय विकास सम्बन्धि अध्ययन परिक्षण

- यस कार्यक्रम अन्तर्गत सि.आइ.पि. पेरुबाट संकलित सुन्तला रंगको गुदी भएको २१ जात र अन्य १९ स्थानिय चार जात गरि जम्मा ४० जातहरुको सखरखण्ड संकलन गरि अध्ययन, संरक्षण र वृद्धि गर्ने कार्य खुमलटारमा भइरहेको छ ।
- सखरखण्डको जातिय विकास कार्यक्रम अन्तर्गत कृषि अनुसन्धान केन्द्र (वागवानी), पोखरामा सि.आइ.पि. क्लोनहरु ४४००१२, ४४०२६७, ४४०१८५, ४४००१५ र ४४००२१ उत्कृष्ठ (३.७५ देखि ९.३६ टन/हे.) ठहरिएका छन् । त्यस्तै क्षेत्रिय कृषि अनुसन्धान केन्द्र, तरहरामा सि.आइ.पि. क्लोनहरु ४४००१२, ४४१६२४ र ४४०३२८ उत्कृष्ठ (३.३ देखि ४.६ टन/हे.) ठहरिएका छन् भने क्षेत्रिय कृषि अनुसन्धान केन्द्र, परवानीपुरमा सि.आइ.पि. क्लोनहरु ४०००३९, ४४०२६७, ४४०१८५, ४४०३२८ र ४४००१५ उत्कृष्ठ (७.२४ देखि ८.७४ टन/हे.) ठहरिएका छन् ।

३.० बीउ उत्पादन

३.१ पूर्व-मूल बीउ आलु उत्पादन

- शरद सिजनमा ११,३०१ र हिउँदे सिजनमा २,५०० गरि जम्मा १३,८०१ ईन भिट्रो बिरुवाहरु प्रयोगशालामा उत्पादन भयो ।
- पूर्व-मूल बीउ आलु (PBS) उत्पादन सम्बन्धमा शरद सिजनमा ५३,३४६ दाना र हिउँदे सिजनमा ७०,५४९ दाना गरि जम्मा १,२३,८९५ दाना PBS उत्पादन भयो ।
- आ.व. २०६९/७० को लागि PBS आलुको मूल्य निर्धारण सम्बन्धमा: सबैभन्दा ठूलाको (५ ग्रामभन्दा माथि) साइजको रु. १०/००, १-५ ग्राम साइजको रु. ८।००, ०.५-१ ग्राम साइजको रु. ६/००, ०.२५-०.५ ग्राम साइजको रु. २/०० र सबैभन्दा सानो ०.२५ ग्रामको रु. १/०० प्रति दाना मूल्य कायम भयो ।

३.२ मूल बीउ आलु उत्पादन

- आ.व. २०६९/७० मा जम्मा ३,०२८ केजी मूल बीउ आलु हात्तिवन फार्ममा उत्पादन भयो ।
- यस आ.व.को लागि पहिलो पुस्ताको मूल बीउ आलु (BS-1) रु. ४२/- प्रति के.जी.; दोश्रो पुस्ताको मूल बीउ आलु (BS-2) रु. ४०/- प्रति के.जी.तथा रु. १,८००/- प्रति बोरा (५० के.जी.) र तेश्रो पुस्ताको बीउ आलु (BS-3) रु. ३८/- प्रति के.जी.तथा रु. १,७१०/- प्रति बोरा (५० के.जी.) को दरले मूल्य निर्धारण भएको छ ।

३.३ धान बीउ उत्पादन

- आ.व. २०६९/७० मा जम्मा १९६० के.जी. धानको मूल बीउ उत्पादन भयो ।
- यस आ.व.को लागि धानको मूल बीउ रु. ६०/- प्रति के.जी. को दरले बिक्रि वितरण गर्ने गरि मूल्य निर्धारण भएको छ ।

EXECUTIVE SUMMARY

1.0 Potato Research

1.1 Potato variety improvement

NPRP has been constantly working in variety development since 1980 with the focus on higher tuber yield, pest and disease resistance, consumers' preference as well as the processing, and the industrial needs. In 2012/13, several activities under this project were undertaken through the collaborators and results are summarized as following:

- Germplasm introduction, maintenance and multiplication of potato clones were continued. In-vitro materials are maintained in NPRP's Tissue culture laboratory and potato tubers from harvested from NPRP Khumaltar ARS (Hort.) Pokhara were stored in the cold store.
- IETs were conducted at NPRP Khumaltar, ARS (Hort.) Malepatan Pokhara and ARS (Hort.) Jumla. The clones selected from Khumaltar were CIP396311.1, CIP397077.16, CIP395192.1, CIP384866.5, PRP056267.6, PRP056267.9, CIP390663.8, CIP399101.1 and CIP395195.7. The clones CIP391058.175, CIP393016.7, CIP396286.6 and CIP377957.5 were selected from ARS (Hort.), Maleptan, Pokhara whereas the clones PRP225861.2, PRP15860.8, and CIP396311.1 were selected from ARS (Hort.), Jumla.
- CVTs were conducted at hills (NPRP Khumaltar and ARS Pakhribas) and at terai (RARS Nepalgunj and RARS Tarahara). At Khumaltar, CIP392228.66 performed well. At ARS Pakhribas, clone PRP35861.18 and PRP55861.6 are selected for farmer's field trials (FFTs). The clones CIP388676.1 and CIP380606.6 are selected for FFTs from RARS Nepalgunj but the clones CIP388676.1, CIP380606.6, PRP225861.2, PRP35861.13 and PRP225861.5 are selected for FFTs from RARS Tarahara.
- The clones CIP393385.39 CIP385499.11 and CIP389746.2 are selected for farmer's acceptance test (FATs) from ARS Pakhribas. From RARS Doti, PRP85861.11, CIP389746.2 and PRP85861.8 are selected for FATs. Likewise, L235-4 found high yielding clones from RARS Nepalgunj and RARS Tarahara. At Nigale Sindhupalchowk, the clone PRP25861.1 is selected for FATs.

1.2 True potato seed (TPS) research

- Evaluation of TPS F_1C_2 tuberlets production in the farmer's field during 2069/70 showed that the TPS family HPS7/67 produced the maximum numbers of tubers (429) per plot and LT 8×TPS-67 produced highest tuber yield 15.37 kg/plot of 7.2 m^2 in Sharadhanager VDC of Chitwan district. In Kusadevi VDC, Kavrepalanchok, the highest (22.67 kg) tuber weight per plot was obtained in LT 8×TPS-13 followed by LT 8×TPS-67 (22.10 kg).The tuber number per plot varied significantly among the evaluated genotypes but weight per plot was statistically not significant).
- Evaluation of F_1C_1 tuberlets of TPS for potato production during 2069/70 revealed that maximum tuber number per plot (581.0) was recorded in genotype LT 8×TPS-67 followed by TPS 7 x TPS-67 (530.0). In contrast, the total weight per plot was highest (22.43 kg) in check variety Kufri jyoti followed by LT 8 x TPS-67 (19.57 kg) in NPRP, Khumaltar. However, maximum tuber number (476.0) and yield (20.0 kg/plot) was recorded in Kufri Sindhuri and Pericholi, respectively, but family LT 8×TPS-13 produced minimum tubers number (187.0) in RARS, Nepalganj.

1.3 Innovative community based agricultural development initiatives for increased climate resilience of people

- Germplasm collection, maintenance and multiplication activity was undertaken at ARS (Hort.) Pokhara and at Hattiban Research Farm Khumaltar. Along with most popular local cultivars of the country, highly promising genotypes from varietal evaluation scheme were selected in the activity. Total of 658 kg from the harvest of pipeline improved potato varieties and 15 to 40 tubers each of the local cultivars was selected and was stored in Balaju cold store to use as the seed materials for next season trials.
- Several sets of PVEs as field experiments were studied in farmers' fields from the command areas of ARS Belachapi, RARS Parwanipur, Bara, RARS Bhairahawa, RARS Doti and RARS Lumle, Kashki as another activity in this project. At Belachapi, the highest yield was obtained highest (20.1 t/ha) from the clone L 235-4 followed by CIP 392206.35 (18.1 t/ha). At Parwanipur Bara conditions, the highest tuber yield was obtained from the clone PRP 35861.18 (20.9 t/ha) followed by farmer's local (16.9 t/ha). In Bhairahawa conditions, the highest yield was obtained from the clone PRP 85861.11 (17.7 t/ha) followed by CIP 392271.58 (13.9 t/ha) and L

235-4 (13.2 t/ha), respectively. In Lumle, the highest yield was obtained from the clone PRP 85861.11 (17.7 t/ha) followed by CIP 392271.58 (13.9 t/ha) and L 235-4 (13.2 t/ha), respectively. In Jumla conditions, variety Kufri Jyoti gave the highest tuber yield tons per hectare (20.2 t/ha) followed by the clone CIP 385499.1 (18.4 t/ha), respectively. Except the variety Desiree, all the tested clones were found high yielding compared to Jumli local. In the trials, some of the clones tested were not influenced by the location and planting season.

1.4 Study on variety improvement of potato for processing

- The genotypes PRP-25861.1, Khumal Seto-1 and L235-4 were promising for higher yield and good processing qualities during main season planting in Kathmandu valley and similar climatic conditions. The genotype Kufri Jyoti is not recommended for processing due to low dry matter content even though it has the highest tuber yield than other tested genotypes.
- Potato genotypes Yagana, L235-4, Kufri Jyoti and Khumal Seto-1 had relatively low weight loss of about 12.3, 14.70, 16.07 and 16.46% respectively up to 120 days storage under dark at ambient room temperature (26.1± 1°C and 62-82% RH) whereas the maximum weight loss (24.35%) in genotype BSUPO3.
- After 120 days storage in cold store and 15 days reconditioning at ambient temperature the potato genotypes Kufri Jyoti and Kufri Chipsona-2 had the higher weight loss of 8.86 and 8.17 percentages respectively, whereas the minimum weight loss (5.25%) was recorded in Khumal Seto-1. Due to increase of reducing sugar none of the genotypes were found suitable for chips making.
- Potato tubers fumigated with CIPC (Oorza) @ 40 ml/l methanol/tons potato (before storage and 45 days after storage) was effective for inhibition of sprouting and reduction of postharvest losses up to 120 days storage in mid-hill and high hills conditions.
- The spacing trial in genotype L235-4 showed no significant variation on processing grade tuber production and total tuber yield in Kathmandu but total yield was significantly higher at a spacing of 60 cm row to row and 25-30 cm plant to plant at farmer's field in Chitwan.
- The verification of seven promising line showed that the genotype Kufri Jyoti and L235-4 were promising in Kathmandu. In Chitwan genotypes did

not differ significantly for total yield of potato but farmers preferred genotype PRP 25861.1 due to its red skin colour.

1.5 Seed potato research

- All tested plant growth retardants showed good effects for long term preservation of potato germplasm under *in - vitro* conditions as compared to standard checked. However, maliec hydrazide (8 ppm) showed better effect by showing slow growth of plants followed by ABA (5 ppm).
- In the hydroponic cultivation for PBS production, the plant establishment and plant height was found good, and tuber formation was also satisfactory compared to the soil based medium. The maximum tuber numbers per plant 81 was observed in Janak Dev in hydroponic whereas, the maximum tuber number was 19 in Khumal Seto-1 under soil base medium. Tuber number as well as tuber yield was found satisfactory in hydroponic cultivation. Under hydroponic cultivation all the tested potato varieties produced higher tuber number and yield with compared to soil base medium cultivation.
- Degeneration studies of PBS under different agro-ecological zones during 2069/70 showed no significant difference on virus status at field as well as laboratory conditions. None of the tested samples were found infected with six potato viruses, however, the virus concentration was varies within the sample as well in the types of viruses.
- Survey was done to collect potato samples and basic information regarding the status of seed potato at different RARSs and ARSs. Such type of survey may help for the optimum utilization of seed potato and ensures the availability of quality seeds. Generation was not properly maintained and local cultivars were found high percentage of virus infection in most of the locations during survey.
- Rosita has been transferred to laboratory for virus elimination and for the same purpose other three samples were also received from NPRP, Khumaltar

1.6 Improving food security and nutrition of rural people in Nepal and Bhutan through collaborative potato breeding for yield stability and micronutrient density

- This is an ADA/CIP-funded three years project in Nepal. Bhutan Potato Development Project (BPDP) implements this project in Bhutan, Li-Bird

one of the NGOs working in Nepal implements this project in Jumla and NPRP/NARC implements its activities in Khumaltar and in Dolakha and Sindhupalchowk districts of central Nepal. To get extension workers, researchers, consumers and farmers acquainted with participatory evaluation of the nutrient-rich potato clones and improved potato production technology at the time of planting, flowering and at harvest were conducted at Nucleus Seed Potato Production Farm (NSPF) Nigaley, Sindhupalchowk district. In all the trainings, the participants were from DADO Dolakha and DADO Sindhupalchowk, NSPF Nigaley and selected potato farmers from Dolakha and Sindhupalchowk districts and different disciplinary divisions and NPRP Khumaltar. It was to involve all the partners in participatory variety selection (PVS).

- In mother trial, number and weight of marketable tubers per plot was obtained highest in the clones CIP 395017.229 (161) and 395112.32 (13.0 kg), respectively. Total weight per plot was produced highest (15.2 kg) by the clone CIP 395112.32 and lowest (1.7 kg) in CIP 390478.9. Total weight per plot ranged from 0.1 kg to 0.5 kg in the trial. Yield was adjusted highest (28.5 t/ha) in the clone CIP 395112.32 followed by CIP 395017.229 (27.6 t/ha) and CIP 393073.179 (24.5 t/ha) respectively. Only the clones CIP 394611.112, CIP 394613.139 were superior to the local check (Rosita).
- The highest weight of marketable tubers/plant was found highest (0.3 kg/plant) in the clones CIP 395112.22 and in CIP 395017.229 (0.3 g), whereas marketable yield per ton was calculated the highest in CIP 395112.32 (24.3 t/ha), CIP 395112.3 followed by CIP 395017.229 (20.9 t/ha) and CIP 393073.179 (17.6 t/ha), respectively.
- Same potato genotypes were tested as baby trials in 4 different farmers' fields of Dolakha and Sindhupalchok districts. Average numbers of marketable tubers were counted highest (96) in variety Rosita.
- Highest weight of marketable quality tubers were recorded in the clone CIP 395112.32 (6.4 kg) followed by CIP 395067.22 (5.7 kg). As in mother trial, the performance of clone CIP 390478.9 was poorer in the baby trials also. Total weight per plot and per plant was obtained highest yield from the clone CIP 395112.32, which influenced tuber yield tons per hectare. The clone CIP 395112.32 was the highest yielder (35.7 t/ha) followed by Rosita (27.5 t/ha). The highest marketable yield per plant and marketable yield tons per hectare was highest in the clone CIP 395112.32 in baby trials. Rosita was second highest in marketable tuber yield production. Except

clones CIP 390478.9, CIP 399092.116, CIP 394611.112 and CIP 394613.139, all other clones tested in the baby trials were observed wart disease susceptible.

- Based on the phenotypic and yield performance of first year, the best clones selected from mother and baby trials will be further assessed in large number of farmers from the locality next year.

1.7 Potato Pathology Research

- Out of 46 potato clones evaluated against late blight disease, most of the clones were observed resistant to late blight. Kufri Jyoti showed significantly highest susceptibility to late blight. Two clones CIP 394050.110 and CIP 395499.11 showed moderately resistant and PRP 25861.1, PRP 016567.12, CIP 393073.179, CIP 393617.1 and CIP 395112.32 observed resistant and rest of the clones were observed highly resistant to late blight with high yielding capacity ranging from 30 t/ha to 56 t/ha.
- Twenty seven clones were screened against late blight in the high hill region, Nucleus Seed Potato Center, Nigale, Sindhupalchowk (2450 masl). Of them, eight genotypes viz. PRP 85861.11, LBr-40, CIP 384321.15, CIP 392657.8, PRP 266264.01, PRP 25861.1, PRP 85861.8 and PRP 276264.01 observed resistant to late blight.
- Four sprays of Sectin @ 1.5 g/l water, sufficient to make plant wet at 9 days intervals, was found to be appropriate on the moderately resistant genotypes Janakdev, L235-4 and CIP 389746.2 for controlling late blight thereby producing considerable yields of 19, 22 and 27 t/ha, respectively. This fungicide could be applied for better management of late blight instead of metalaxyl containing fungicides.
- Twenty six potato genotypes were screened against wart (*Synchitrium endobioticum*) under inoculated pot culture, exposing natural environmental conditions at Nigale (2450 masl). Of them, nine genotypes viz. CIP 393077.54, PRP 225861.2, PRP 85861.8, PRP 266264.15, CIP 394050.110, CIP 393280.57, PRP 85861.11, PRP 25861.1 and CIP 393385.39 observed resistant to wart. Commercial variety Janak Dev and Kufri Jyoti along with BSUPO3 and CIP 399261.18 observed highly resistant to wart. Local variety Rosita observed highly susceptible to wart with 93% disease incidence.

- Seed treatment with 8% Uthane M- 45 for 30 minute and shade drying before planting of tubers reduced disease incidence by 57% followed by 4% Antracol (52%) and seed treatment with 2% bleaching powder along with soil treatment @ 25 Kg a.i./ha at Sharadanagar, Chitwan. Planting of apparently healthy tubers at severely infested soil reduced disease incidence only 44%.
- In participatory multi-location late blight varietal experiments, genotype PRP 266264.15 produced highest tuber yield in Chitwan (32.6 t/ha) and Bardia (46.0 t/ha). Promising line CIP 389746.2 produced highest tuber yield in Kaski (46.0 t/ha). Tuber production of new genotypes was significantly highest as compared to the yields of respective old varieties Janakdev and MS-42.3 ranging tuber yield from 4 to 23 t/ha. Fungicide was not applied throughout the crop period in all the locations.

2.0 Sweet Potato

2.1 Sweet potato variety improvement

- Under germplasm collection, maintenance and evaluation activity, 21 orange-fleshed sweet potato clones from CIP and other 19 local germplasm from different parts of the country were collected and maintained under *in vivo* condition at NPRP, Khumaltar.
- In the coordinated varietal trial (CVT), at ARS (Horticulture), Pokhara the promising clones were CIP 440012, CIP 440267, CIP 440185, CIP 440015 and CIP 440021 with average yield ranging from 3.75 - 9.36 t/ha. In RARS, Tarahara, CIP clones of 440012, 441624 and CIP 440328 were found to be promising with the yield ranging from 3.3 - 4.6 t/ha. In case of RARS, Parwanipur, CIP clones 400039, 440267, 440185, 440328 and 440015 produced the highest yield ranging from 7.24 to 8.74 t/ha.

3.0 Seed Production

3.1 Pre-basic seed potato

- Overall 11,301 *in vitro* plantlets of ten potato cultivars in autumn season and 2,500 *in vitro* plantlets of six cultivars in spring season were produced in the tissue culture laboratory.
- In the F.Y. 2012/13, altogether 123,895 pre-basic seed potatoes (53,346 in autumn season and 70,549 in spring season) were produced.

- The per unit price of PBS fixed for 2012/13 was Rs. 10.00 for larger than five gram sized minituber, Rs. 8.00 for 1-5 g sized, Rs. 6.00 for 0.5-1 g sized, Rs. 2.00 for 0.25 -0.50 g and Rs. 1.00 for smaller than 0.25 g size minitubers.
- Total of 74 potato germplasm have been maintained under *in vitro* condition at NPRP laboratory.

3.2 Basic seed potato

- In the basic seed production program, overall 3,028 kg of basic seed (BS-1, BS-2 and BS-3) potatoes were produced.
- The price of basic seed fixed for 2012/13 was Rs. 42.00 per kg for BS-1; Rs. 40.00 per kg and Rs. 1,800.00 per sack of 50 kg for BS-2, and Rs. 38.00 per kg and Rs. 1,710.00 per sack of 50 kg for BS-3.

3.3 Rice seed

- In the rice seed production program, overall (1960 kg) one ton nine hundred sixty kilogram of rice foundation seed of Khumal-4 was produced.
- The price of rice foundation seed fixed for the fiscal year 2012/13 was Rs. 60.00 per kg.

1. WORKING CONTEXT

Potato (*Solanum tuberosum* L.) is one of the most important crop in Nepal. It is utilized as a major vegetable in *Terai* and mid- hills and used as a vegetable and staple food in high hills. In the year of 2011/12 area under potato was reported 190, 250 ha and total production 2,584,301 tons with an average productivity of 13.584 t/ha (Table 1). It occupies the fifth position in area coverage, second in total production and first in productivity among the food crops grown in Nepal. It serves as a staple food in the high hills and plays a vital role in the food security in the country. Out of the total area under potato, around 19% is in the high hills and mountains, 44% in the mid-hills and 37% in *Terai* (ABPSD, 2012).

Table 1. Area, production and productivity comparison of food crops in Nepal

Food crops	Area (ha)	Rank	Production (tons)	Rank	Productivity (t/ha)	Rank
Potato	190,250	V	2,584,301	II	13.584	I
Paddy	1,531,493	I	5,072,248	I	3.312	II
Maize	871,387	II	2,179,414	III	2.501	III
Wheat	765,317	III	1,846,142	IV	2.412	IV
Millet	278,030	IV	315,067	V	1.113	V

Source: Ministry of Agriculture Development, Agri-business Promotion and Statistics Division, Singh Durbar, Kathmandu, Nepal (2012).

As compared to the three years average of 1987/88 to 1989/90, the area, production and yield of potato in 2011/12 is increased by 233, 412 and 177 times, respectively (Fig. 1).

Geographically, Nepal can be categorized into three geographical regions - southern lower belts Terai, central mid-hills and northern high-hills and mountains. Since eastern Nepal is humid and western Nepal is very dry, the country can, agro-ecologically, categorized into eastern wet hills and terai, central hills and terai, and western dry hills and terai. To cover up the almost all agro-ecological zones prevailing in the country, NPRP has been conducting its research projects, especially varietal improvement ones, in ARS, Pakhribas, Dhankuta (eastern wet hill), RARS, Tarahara, Sunsari (eastern wet terai), NPRP, Khumaltar, Lalitpur (central hill), RARS, Parwanipur, Bara (central terai), HRS, Malepatan, Kaski (western hill), HRS, Rajikot, Jumla (mid-western high hill), ARS, Surkhet (mid-western hill), RARS, Khajura, Banke (mid-western terai) and RARS, Bhagetada, Doti (far-western hill) (Annex 1.1).

This fiscal year the temperature of the Khumaltar, Lalitpur ranged from 0.9°C in January 2013 to the maximum 28.8°C in July 2012. Similarly, no rainfall at all was recorded in December 2012 and the highest of 366 mm in July 2012 (Annex 1.2).

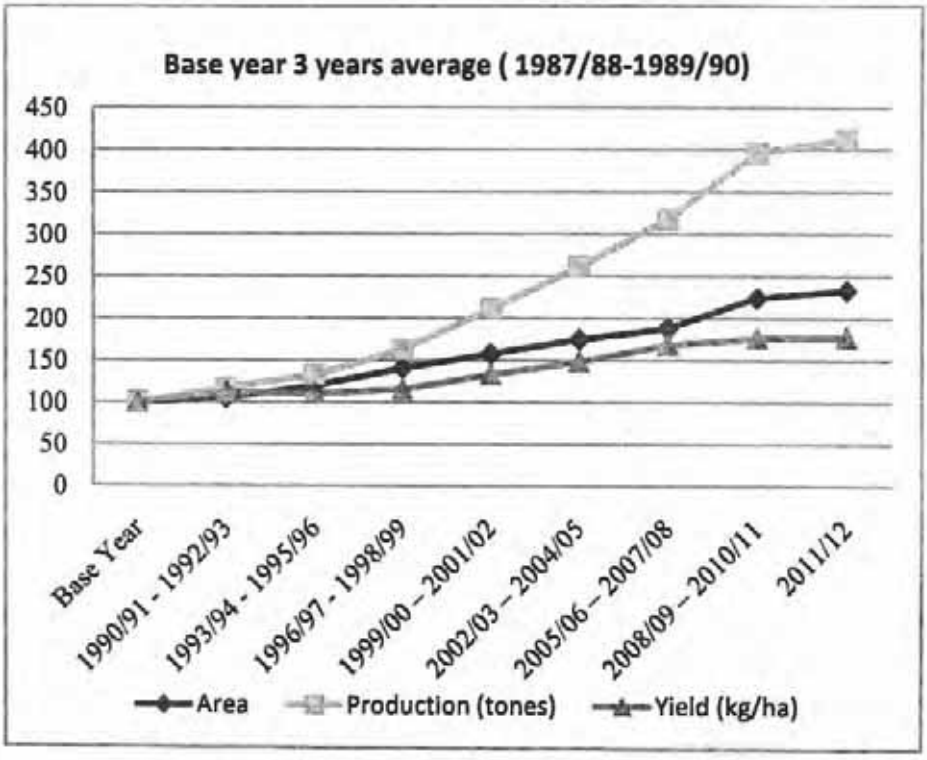


Fig. 1. Index of potato area, production and yield in Nepal.

2. INTRODUCTION

The first official attempt to improve potato production was initiated in 1962 under a joint programme between Nepal and India. During its earlier phase (1960-75), several potato farms and other infrastructures were developed in Nepal. With the increased importance of potato crop in national food production, National Potato Development Programme (NPDP) was incepted in 1972 at Kirtipur with a nationwide mandate to conduct potato research and development activities. Two potato farms, one at Jaubari, Ilam and another at Nigale, Sindhupalchowk, were established during 1980s. In 1974, NPDP was relocated to Khumaltar and linkages were established with International Potato Center (CIP) Lima, Peru, which is still effective.

During the early phase of the programme, major focus was on seed potato production through contract system with the farmers. Later on in 1989, a tissue culture laboratory was established with the financial and technical support of Swiss government and the contract growers were encouraged to form a cohesive group for informal production of high quality seed. Source seed as pre-basic seed is to date being supplied by the tissue culture laboratory.

In 1991, with the establishment of Nepal Agricultural Research Council (NARC), NPDP was separated into two programs, National Potato Research Programme (NPRP) and the then Potato Development Section (PDS), now National Potato Development Programme (NPDP) with specific mandates on extension and development respectively. As a national commodity research programme, NPRP is responsible for launching appropriate research projects on potato crop throughout the country to improve the livelihoods of Nepalese farmers.

2.1 Goal

To improve the livelihoods of Nepalese farmers through root and tuber crops.

2.2 Objectives

- Generate suitable and stable appropriate technologies to increase the production and productivity of root and tuber crops for different agro-ecological zones of the country through coordinated research approach,
- Identify and solve production constraints of seed and ware potatoes through on station and farmer's participatory multi location on-farm research,
- Produce high quality healthy source seed of released/recommended potato varieties,

- Identify and develop appropriate varieties for processing and storage under ordinary conditions.
- Establish coordination with potato stakeholders in the country,
- Develop and strengthen linkages between national and international potato R & D related organizations, and

To achieve above mentioned objectives following projects were conducted during the year 2012/13

- Potato variety development and improvement for different agro-ecologies of Nepal,
- Innovative community based agricultural development initiatives for increased climate resilience of people
- Study on variety improvement of potato for processing,
- Sustainability studies for pre-basic seed production of potato,
- Improving food security and nutrition of rural people in Nepal and Bhutan through collaborative potato breeding for yield stability and micronutrient density
- Studies on management of late blight, wart and powdery scab diseases of potato in Nepal,
- Evaluation of TPS F_1C_2 tuberlets production in the farmers field
- Pre basic and source (basic) seed production of potato, and
- Sweet potato variety development for food and nutrition security,
- Farm management project

NPRP also manages a full-fledged tissue culture laboratory for the pre-basic seed (PBS) potato production. About 100,000 to 200,000 minitubers of different varieties are produced each year under quarantine glasshouse conditions at Khumaltar and distribute to seed growers through National Potato Development Programme/DOA. PBS is also further multiplied in Horticulture Farms under NARC and DoA for basic seed production to meet the farmer's demand of their respective command areas.

CIP Peru and its Regional Office, Delhi are supporting for potato research in Nepal in the field of technology generation and supply of potato germplasms. Farmer's participatory researches on adaptation of TPS families have also been implemented in collaboration with CIP Regional Office, Delhi.

2.3 Strategies

The strategy of NPRP is to carry out the research activities and support quality seed potato production program, for overall potato production improvement throughout the country.

2.4 Current thrust areas for research

- High yielding and late blight disease resistant potato variety development for different agro-ecologies of Nepal,
- High yielding and micronutrient (Zn and Fe) rich variety development on potato for high hills
- Determine the optimum practices of cultivation of potato in relation to the soil-cultivars-climate complex
- Identify and investigate on major diseases and pests of potato and devise their control measures
- Investigate on problems connected with post harvest and processing
- Develop system based soil fertility management practices
- Socio-economic studies on adoption of new technological and cost effectiveness in farming communities
- Develop improved farm equipment and implement on potato cultivation
- Make existing quality seed production activities sustainable
- Use of biotechnology in crop improvement
- High yielding and β-carotene enriched sweetpotato variety development for different agro-ecologies of Nepal, and
- Pre-basic and source (basic) seed production on potato.

2.5 Infrastructure and facilities

The program has its own office building in Khumaltar, NARI complex; a glasshouse and screenhouse complex in NASRI complex and a research farm in Hattiban (Annex 2.1).

Altitude:	1350 masl	Land type: Alluvial terraces
Dominant soil type:	Silty loam	Dominant soil pH: 5.5
Climate type:	Sub-tropical	

Area	Ropani*
Total cultivated area	32
Area covered by glasshouse complex	20
Area covered by office buildings and laboratories	5
Area covered by housing/quarters	¼
Area covered by irrigation & drainage channels	3

- 1 ropani = 500 m^2

The office building is equipped with a tissue culture laboratory, a pathology laboratory, a postharvest laboratory, a plant physiology laboratory and a screen house (Annex 2.1).

2.6 Organization structure and human resource

The organization structure of NPRP (Fig. 2) explains the working modality and human resources strength that is adopted to help in achieving the objectives and strategies of the programme. The programme has altogether 29 staffs composed of scientists, technical officers, technicians, helpers, administrative officer and account officers (Annex 2.2).

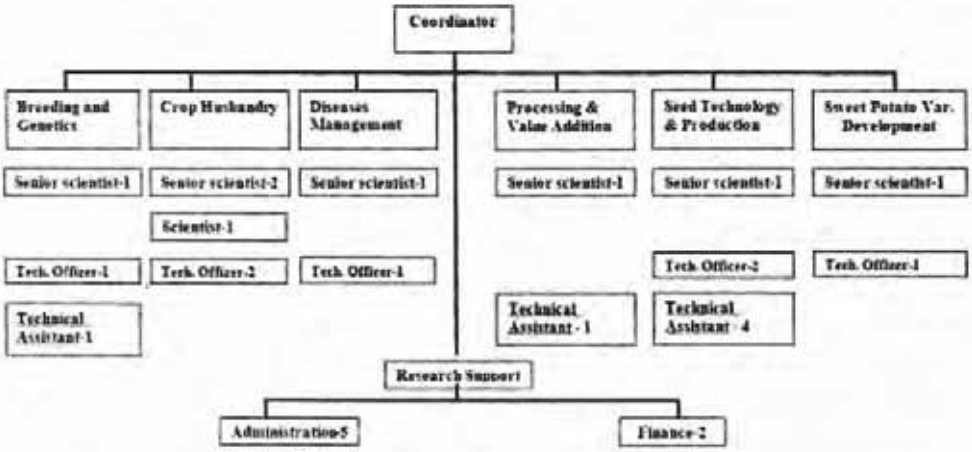


Fig. 2. Organogram of the National Potato Research Programme

3. RESEARCH HIGHLIGHTS

3.1 Potato

3.1.1 Variety Improvement/Development

National Potato Research Programme (NPRP) has been constantly working in variety development since 1980 with the focus on higher tuber yield, pest and disease resistance, consumers' preference as well as the processing, and industrial needs. With the continuous effort of variety development, NPRP has succeeded in releasing ten potato varieties so far in different agro-ecological regions for commercial production along with the registration of two TPS progenies. Germplasm introduction and inter-varietal hybridization are employed to develop the variety on potato at NPRP.

The germplasm of potato has been regularly introduced in NPRP from International Potato Center (CIP), Lima, Peru since 1980s. The variety testing and selection are the fundamental processes to obtain the new variety, which are followed in the variety improvement program in potato. NPRP follows a varietal evaluation and testing scheme particularly on advanced clones bred from CIP Lima and at Khumaltar. The germplasm are first multiplied in *in-vitro*, or in field conditions, and then under screen-house conditions, followed by preliminary evaluation in observation nurseries (PON) at Khumaltar and ARS (Hort.) Pokhara. The superior clones are bulked at both locations and the clones selected from this stage are further tested as Initial Evaluation Trials (IETs), and later as Coordinated Varietal Trials (CVTs) in different collaborative farms and stations throughout the country.

Most promising lines from CVT are further tested in CFFTs as Coordinated Farmers' Field Trials (CFFTs) which is carried out at out-reach research sites of different research stations. In all the on-station trials, performance of the tested clones is recorded, whereas in on-farm trials farmers' preferences are additionally recorded. After two or more than two years' of farmers' field trials, the most preferred clones are recommended for commercial cultivation in respective ecological domain of the country, and then a proposal is submitted to Variety Releasing Committee for releasing the clone as a variety.

3.1.1.1 Initial evaluation trial (IET)

IET is the first step of variety screening of potato for selecting high yielding, disease resistance (particularly late blight) as well as pests' resistance and widely adaptable variety in different agro-ecological zones. To carry-out the initial evaluation trial, three sites namely; Hattiban Research Farm, Khumaltar, ARS

(Hort.) Rajikot, Jumla and ARS (Hort.) Pokhara, were selected as the representative sites for summer season and winter season crop, respectively.

At NPRP Khumaltar, twenty-one potato clones were evaluated for their vegetative and yield performance in 2069/70. Similarly, twenty-one clones were tested at ARS (Hort.) Pokhara and twenty clones at ARS (Hort.) Jumla with check varieties Desiree and Kufri Jyoti at Khumaltar, Desiree and Kufri Sindhuri at ARS (Hort.) Pokhara and Desiree, Kufri Jyoti, Cardinal and Jumli local at Jumla. In all the locations, trials were laid out in randomized complete block design (RCBD) with three replications. The plots were fertilized @100:100:60 kg N,P_2O_5,K_2O together with 20 tons of compost per hectare. All the fertilizers and farm yard manure was applied at the time of planting as basal dose. Well-sprouted tubers ranging from 20 to 50 gm sizes were planted in a rod-row design with 60 x 25 cm row to row and plant to plant spacing. Following parameters were recorded in the trials:

Growth parameters

1. Emergence (%) at 15 and 30 days after planting in winter season trial and 30 and 45 days in summer season trials
2. Plant height (average of 5 plants /clone in each replication)
3. Plant uniformity (after 6 weeks of planting at 1-5 scale)
4. Plant vigor (after 6 weeks of planting at 1-5 scale)
5. Number of main stems per plant (average of 5 plants in each replications), and
6. Late blight rating (using 1-9 scale)

Yield and Yield parameters

1. Number of plants harvested
2. Number and weight fraction of the tubers in three grades (small, medium and large size categories)
3. Total number and weight of tubers/plot
4. Yield tons per hectare, and
5. Color, shape and eye depth of the tubers

In the initial evaluation trial of potato at Hattiban Research Farm, twenty-one potato genotypes were evaluated along with Desiree and Kufri Jyoti (Table 1.1). The plant emergence was ranged from 92 to 100% in the tested clones. The ground cover was highest (95%) in CIP380606.6 and the lowest (37%) was in PRP266265.1. The plant uniformity was highest (5) in PRP056267.6, CIP395195.7, and CIP380606.6 and the lowest (1) was in CIP397073.15 and PRP226267.3. The plant vigor was highest (5) in CIP396311.1, CIP397077.16, CIP395192.1, PRP056262.1, PRP056267.6, PRP056267.9, CIP399101.1, CIP390663.8, CIP395195.7, CIP380606.6 and PRP226267.11 whereas the highest (6) number of main stems per

plant was counted in CIP380606.6 followed by PRP056267.1 (5) and PRP226267.11 (5). The highest (59.8 cm) plant height was measured in CIP395192.1 followed by PRP226267.11 (59 cm) and the lowest (27.3 cm) was in PRP15860.8.

Table 1.1: Plant and yield characters of potato clones tested in IET at Khumaltar, 2069/70

Clones	Emg (%)	Ground cover (%)	Pt unif (1-5)	Pt vig (1-5)	Stem plant (no.)	Pt ht (cm)	Tuber size distribution (No. and Wt., kg)						Total tuber/plot		Adj yld (t/ ha)
							US		SS		OS				
							No.	Wt.	No	Wt.	No.	Wt.	No	Wt (kg)	
CIP396311.1	100	82	3	5	4	38.1	41	0.3	67	3.7	15	2.4	122	6.4	26.5
CIP397073.15	92	40	1	4	3	39.9	28	0.2	48	2.4	7	0.9	83	3.8	16.1
CIP397077.16	97	80	4	5	3	35.7	49	0.4	59	3.2	15	2.3	123	6.1	25.5
CIP395192.1	92	82	4	5	4	59.8	43	0.3	74	4.4	11	2.0	128	7.2	30.1
CIP384866.5	100	52	3	3	3	37.7	47	0.3	59	2.3	8	0.7	114	3.3	13.7
PRP15860.8	100	47	4	3	4	27.3	44	0.3	65	2.0	2	0.3	111	2.6	10.8
PRP056267.1	100	65	4	4	5	41.9	118	0.9	106	4.1	4	0.4	228	5.4	22.5
PRP056267.6	100	80	5	5	2	46.7	55	0.3	67	3.1	15	2.3	137	5.7	23.8
PRP056267.9	97	82	4	5	4	47.7	113	0.8	115	4.3	7	0.8	236	6.0	25.3
PRP266265.1	97	37	2	3	3	39.3	30	0.3	37	1.4	8	0.5	75	2.2	9.3
CIP391058.175	100	45	2	3	3	36.4	31	0.3	55	2.3	6	0.7	92	3.4	14.2
PRP85861.11	100	57	3	3	2	35.2	52	0.5	75	3.3	7	0.8	133	4.5	18.8
CIP390663.8	100	82	4	5	3	43.1	34	0.3	48	2.9	16	2.8	98	6.0	25.3
CIP399101.1	96	65	4	5	4	55.6	70	0.4	91	4.3	9	0.9	170	5.9	24.8
PRP25963.7	94	53	3	4	3	43.7	14	0.2	26	1.5	7	0.8	47	2.6	10.8
CIP395195.7	100	77	5	5	3	54.1	44	0.5	64	3.8	16	2.7	124	7.1	29.4
CIP380606.6	100	95	5	5	6	51.9	149	1.5	163	6.5	10	1.0	322	9.0	37.6
PRP146267.6	100	70	4	4	3	46.9	21	0.3	52	3.1	11	1.9	84	5.2	21.8
PRP146267.7	100	73	4	4	3	48.1	40	0.4	63	3.3	11	1.6	115	5.3	22.3
PRP226267.3	100	45	1	4	4	41.8	52	0.5	40	1.4	5	1.7	97	3.6	14.9
PRP226267.11	100	70	4	5	5	59.0	62	0.5	93	3.9	22	0.8	177	5.2	21.6
Desiree (ch)	100	50	3	3	4	29.4	20	0.2	48	2.0	7	0.8	75	3.2	13.1
K. Jyoti (ch)	100	65	4	4	4	33.6	42	0.4	61	3.7	11	1.9	115	6.0	25.3
Mean															21.1
F-Test															**
LSD (0.05)															7.0

The number and weight of under size tubers were produced the highest (149 and 1.5 kg, respectively) in CIP380606.6 whereas the highest number and weight of seed sized tubers were obtained in CIP380606.6 and the values were 163 and 6.5 kg, respectively. But the number of oversized tubers was maximum (22) in PRP226267.11 and the highest (2.8 kg) weight was obtained in CIP390663.8. The total number and weight of tuber per plot were highest (322 and 9.0 kg, respectively) in CIP380606.6 but the lowest number (47) and weight (2.2 kg) were in PRP25963.7 and PRP266265.1, respectively. The tuber yield was highly significant (<0.001) among the tested clones. The highest (37.6 t/ha) tuber yield was recorded in CIP380606.6 followed by CIP395192.1 (30.1 t/ha) and CIP395195.7 (29.4 t/ha) and the lowest (9.3 t/ha) was in PRP266265.1. Based on two years' results, clones CIP396311.1, CIP397077.16, CIP395192.1, CIP384866.5, PRP056267.6, PRP056267.9, CIP390663.8, CIP399101.1 and CIP395195.7 are promoted to CVTs whereas CIP397073.15, PRP15860.8, PRP056267.1, PRP266265.1, CIP391058.175, PRP85861.11 and PRP25963.7 are rejected from

the varietal evaluation scheme and remaining clones are recommended to repeat for next year's initial evaluation trial.

At ARS (Hort.) Malepatan, twenty potato genotypes were evaluated. The varieties MS42-3, Desiree, and K. Sindhuri were used as the check (Table 1.2). The highest (96 %) tuber emergence was recorded in CIP393248.55 and the lowest (79%) in PRP266265.15 and Desiree. The plant uniformity ranged from 3 to 5 (1-5 scale) in all the tested clones. The ground cover was highest (93%) in PRP056267.6 and PRP146267.7 and the lowest (55%) in Desiree. The highest (43 cm) plant height was measured in PRP286265.22 and the lowest (19 cm) in CIP393248.55.

Table 1.2: Plant and yield characters of potato clones tested in IET at ARS, Malepatan, 2069/70

Genotypes	Emg. (%)	Plant unif. (1-5)	Ground cover (%)	Plant ht. (cm)	Stem/ Plant (no.)	LB disease (1-9)	Tuber size distribution (no. and wt., kg)						Total tuber/plot (no.)	Total wt./plot (kg)	Total yield (t/ha)
							US		SS		OS				
							No.	Wt.	No.	Wt.	No.	Wt.			
PRP056267.1	83	4	82	27	4	5	41	0.4	80	3.3	15	1.5	137	6.2	25.9
PRP266265.1	79	5	90	23	3	1	19	0.1	55	2.5	13	1.4	88	5.4	22.3
PRP266265.1	83	3	75	33	3	1	43	0.4	79	3.2	17	1.9	139	7.1	29.7
PRP226267.1	90	4	90	37	2	1	32	0.4	59	2.9	21	2.9	112	7.3	30.5
PRP266265.4	85	4	70	23	2	1	22	0.2	54	2.2	12	1.4	88	4.6	19.3
PRP25861.1	90	4	83	30	3	5	24	0.3	58	2.5	10	1.2	91	4.6	19.3
PRP25861.11	90	4	65	21	4	2	37	0.2	69	2.5	18	1.6	124	5.0	21.1
PRP056267.6	81	5	88	27	4	2	36	0.3	69	2.8	14	1.6	119	5.7	23.5
PRP056267.9	94	5	93	27	5	3	86	0.7	101	3.6	6	0.5	192	5.7	23.5
PRP146267.7	90	5	93	28	3	1	25	0.2	53	2.4	22	2.5	100	6.1	25.4
CIP392227.15	85	3	60	22	3	5	11	0.1	42	1.6	2	0.2	55	2.5	10.2
CIP391058.17	92	5	82	37	2	1	20	0.2	68	3.1	18	2.0	106	6.4	26.6
CIP393016.7	94	4	83	29	3	1	18	0.1	71	2.9	12	1.3	101	5.0	20.9
CIP396286.6	94	5	78	28	4	1	36	0.3	89	3.1	15	1.2	140	5.5	22.7
CIP393248.55	96	5	73	19	3	1	20	0.1	57	2.4	5	0.5	82	3.6	14.8
CIP377957.5	85	4	82	32	2	2	15	0.1	63	3.0	16	2.2	94	6.5	27.0
PRP85861.6	94	3	68	24	2	1	16	0.1	47	2.1	11	1.5	74	4.3	18.0
PRP276264.1	85	5	82	33	2	2	34	0.2	75	3.4	15	1.7	125	6.4	26.7
PRP146267.6	92	4	72	29	2	2	23	0.2	55	2.3	17	2.2	95	5.3	21.9
PRP286265.2	83	5	90	43	3	2	23	0.2	62	3.3	14	2.4	100	7.0	29.4
MS-42.3 (ch)	92	5	80	28	2	3	44	0.3	57	2.3	13	1.1	113	4.5	18.9
Desiree (ch)	79	3	55	23	2	3	19	0.1	36	1.2	5	0.4	59	2.2	9.5
K. Sindhuri (ch	94	4	82	33	3	2	73	0.5	96	3.3	10	1.0	179	5.6	23.4
Mean															22.2
F Test															**
LSD (0.05)															6.5

The average number of main stems per plant was varied from 2 to 5 among tested clones. Clones PRP266265.15, PRP266265.1, PRP226267.11, PRP266265.4, PRP146267.7, CIP391058.175, CIP393016.7, CIP396286.6, CIP393248.55, and PRP85861.6 found highly resistant late blight disease scoring 1 in 1 to 9 scale, whereas PRP056267.1, PRP25861.1, CIP392227.15 found susceptible.

The number and weight of under size tubers were obtained the highest (86 and 0.7 kg, respectively) in PRP056267.9 whereas the highest seed sized tubers number (101) and weight (3.6 kg) from PRP056267.9. The number and weight of oversized tubers were obtained the highest in PRP146267.7 (22) and PRP226267.11 (2.9 kg), respectively. The total number and weight of tuber per plot were highest in Kufri Sindhuri (179) and PRP226267.11 (7.3 kg), respectively. Clone PRP226267.11

gave the highest yield (30.5 t/ha) followed by PRP266265.1 (29.7 t/ha) and the lowest (9.5 t/ha) in Desiree. Based on two years' results, clones CIP391058.175, CIP393016.7, CIP396286.6, and CIP377957.5 are selected for CVT whereas CIP392227.15, and CIP393248.55 are rejected and remaining clones are recommended to re-test for one year more.

At ARS (Hort.) Jumla, twenty potato genotypes were evaluated and compared with Desiree, K. Jyoti, Cardinal and Jumli local (Table 1.3). The tuber emergence ranged from 58 to 100% in tested potato clones. The ground cover was highest (95%) in CIP397077.16, PRP056267.1, CIP395195.7, PRP056267.9 and Kufri Jyoti and the lowest (23%) was in PRP15860.8. The average number of main stems per plant was counted highest (4) in CIP388676.1 and PRP056267.9. Likewise, the tallest plants were measured in PRP226267.11 (51 cm) and the shortest (15 cm) was in PRP85861.11.

The number and weight of undersized tubers were obtained the highest in PRP056267.1 (55) and Desiree (0.7 kg), respectively. The number of seed sized tubers counted the highest (44) in PRP056267.1 whereas the highest weight (1.5 kg) was in PRP056267.9. The number of oversized tuber counted the highest in K. Jyoti (29) whereas the highest weight (1.7 kg) was in PRP056267.6, CIP395195.7, K. Jyoti and Jumla Local. Likewise, the total tuber number per plot was counted highest (101) in PRP056267.1 and weight was in PRP226267.11 (3.5 kg). The yield obtained was significant (<0.05) among the tested clones. The clone PRP226267.11 gave the highest (14.7 t/ha) yield followed by CIP395195.7 (13.3 t/ha) and the lowest (3.9 t/ha) yield was in PRP266265.1. Tuber color varied from red to white in tested clones and tuber shape was observed as round, long shaped, and oblong among the clones. Based on two year's data, clones PRP225861.2, PRP15860.8, and CIP396311.1 are rejected whereas CIP397077.16 is promoted for coordinated varietal trial and remaining clones are recommended to re-test at the same research station.

Table 1.3: Plant and yield characters of potato clones tested in IET at Jumla, 2069/70

Clones	Emg (%)	Ground cover (%)	Stem/ plant (no.)	Plant height (cm)	Tuber size distribution (No. & Wt., kg)						Total tuber/plot		Adjusted yield (t/ha)	Tuber color	Tuber shape
					US		SS		OS						
					No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt (kg)			
CIP380606.6	58	50	3	44	29	0.3	30	0.9	5	0.3	64	2.2	9.1	R	Ro
CIP397077.16	96	95	2	32	15	0.2	9	0.6	24	1.6	47	2.6	10.8	W	L
PRP225861.2	92	70	2	36	19	0.2	19	0.7	11	0.9	48	1.9	7.9	W	Ob
PRP25963.7	100	65	2	35	9	0.1	10	0.4	10	0.7	28	1.2	4.9	R	Ob
PRP056267.1	100	95	3	40	55	0.6	44	1.4	3	0.1	101	2.1	8.9	R	Ro
PRP056267.6	100	90	3	46	11	0.5	14	0.5	20	1.7	44	2.7	11.2	R	Ro
CIP384866.5	100	80	3	39	27	0.3	27	0.8	13	0.9	66	2.1	8.9	W	Ro
CIP391058.175	96	80	2	39	5	0.6	22	0.7	15	1.2	41	2.6	10.8	R	Ro
PRP266265.1	100	45	2	30	19	0.2	16	0.5	6	0.3	41	0.9	3.9	W	Ob
PRP15860.8	83	23	2	17	29	0.2	17	0.5	3	0.1	49	1.0	4.5	W	L
PRP146267.7	96	80	2	45	19	0.5	18	0.8	12	0.7	48	2.3	9.4	W	Ro
CIP395195.7	96	95	3	43	12	0.5	28	0.8	25	1.7	65	3.2	13.3	W	L
PRP85861.11	96	58	2	15	27	0.2	17	0.5	5	0.3	49	1.0	4.4	R	Ob
PRP226267.3	100	90	3	46	26	0.3	36	1.2	13	1.0	75	2.6	10.5	R	L
PRP146267.6	92	80	2	43	10	0.4	19	0.8	13	1.4	41	2.8	11.9	W	Ob
PRP226267.11	79	90	2	51	17	0.5	32	0.9	12	1.1	59	3.5	14.7	W	Ob
CIP396311.1	75	60	2	25	25	0.2	16	0.5	7	0.5	48	1.6	6.8	R	L
CIP399101.1	75	85	2	37	19	0.2	27	0.9	6	0.5	52	2.2	9.3	W	Ob
CIP388676.1	71	70	4	36	10	0.5	17	0.6	11	0.9	38	2.9	12.1	W	Ob
PRP056267.9	96	95	4	38	41	0.5	35	1.5	10	0.7	85	2.9	12.3	W	Ro
Desiree (ch)	100	85	3	23	18	0.7	17	0.6	17	1.5	51	2.8	11.7	R	L
K. Jyoti (ch)	100	95	3	31	23	0.3	23	0.9	29	1.7	75	2.9	12.1	W	O
Cardinal (ch)	100	85	2	20	22	0.2	30	1.2	13	1.0	67	2.4	9.9	R	L
Jumla Local (ch)	100	90	3	38	23	0.2	24	0.8	19	1.7	65	2.7	11.5	W	Ob
Mean													9.63		
F-Test													*		
LSD (0.05)													5.82		

3.1.1.2 Coordinated varietal trial (CVT)

CVT is the second step of multi-location on-station testing of varietal evaluation. The clones selected from IETs are included in this step for further selection in different research stations of the country. Under this trial, the selected clones from IET are generally assessed for two years and only the most promising ones are recommended to test in farmers' field trials (FFTs).

In 2013/14 too, CVTs were conducted at NPRP Khumaltar, ARS Pakhribas in the hills and at RARS Nepalgunj and RARS Tarahara in terai. In all the research stations, the trials were laid out in randomized complete block design (RCBD) with four replications. The plot size was maintained at 7.2 m^2 in all the locations, with the spacing of 60 x 25 cm between the rows and plants, respectively.

The data collected were:

Growth parameters

1. Emergence (%) at 15 and 30 days after planting in winter season trial and 30 and 45 days in summer season trials
2. Plant height (average of five plants/clone in each replication)
3. Plant uniformity (after 6 weeks of planting at 1-5 scale)

4. Plant vigor (after 6 weeks of planting at 1-5 scale)
5. Number of main stems per plant (average of 5 plants in each replications), and
6. Late blight rating (using 1-9 scale)

Yield and Yield parameters

1. Number of plants harvested
2. Number and weight fraction of the tubers in three grades (small, medium and large)
3. Total number and weight of tubers/plot
4. Yield tons per hectare
5. Color, shape and eye depth of the tubers

At Hattiban Research Farm of Khumaltar, a CVT was conducted with five potato varieties where Desiree and Kufri Jyoti were used as check varieties (Table 1.4). The tuber emergence was observed highest (100%) in CIP392228.66, CIP377957.5, Desiree and K. Jyoti and the lowest (85%) was in CIP392244.3. The ground cover was measured highest (59%) in CIP392244.3 followed by K. Jyoti (55%) and the lowest (35%) was in CIP394034.65. The plant uniformity ranged 3 to 4 (1-5 scale) in all the tested clones. The highest (4) plant vigor was observed in CIP392244.3 followed by K. Jyoti. The average plant height was highest (33.0 cm) in Kufri Jyoti and the lowest (19.1 cm) was in CIP394034.65. The number of main stems per plant was highest (5) in CIP388676.1 and the lowest (3) was in CIP394034.65.

The highest number and weight of under size tubers were recorded in CIP392244.3 (454 and 3.3 kg, respectively) but the highest (302) number of seed sized tubers occurred in CIP3922444.3. The weight of seed sized tubers was highest (12.5 kg) in K. Jyoti. Likewise, the number and weight of oversized tuber were highest (51 and 6.6 kg) in Kufri Jyoti. Total tuber number and weight per plot was produced the highest by the clone CIP392244.3 (782) and K. Jyoti (20.9 kg), respectively. The yield was highly significant (<0.001) among the potato genotypes. Kufri Jyoti gave the highest yield (29.1 t/ha) followed by CIP392244.3 (28.9 t/ha) and the lowest (12.3 t/ha) was in CIP394034.65. From this evaluation, CIP392228.66 is promoted for coordinated farmer's field trial while CIP394034.65 is rejected from this evaluation and remaining clones are recommended to repeat for one season more.

Table 1.4: Plant and yield characters of potato clones tested in CVT at Khumaltar, 2069/70

Clones	Emg. (%)	Ground cover (%)	Plan unif. (1-5)	Plant vig. (1-5)	Plan heigh (cm)	Stem/ plant (no.)	Tuber size distribution (No. and Wt., kg)						Total tuber /plot		Adj. yield (t/ha)
							US		SS		OS				
							No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.(kg)	
CIP394034.65	96	35	3	2	19.1	3	163	1.4	179	6.1	13	1.0	355	8.8	12.3
CIP392228.66	100	48	4	3	26.7	4	272	2.3	253	9.4	19	1.8	544	13.4	18.6
CIP388676.1*	94	43	4	3	25.1	5	235	1.9	280	10.2	36	4.1	550	17.3	24.0
CIP377957.5	100	46	4	3	27.0	4	246	2.2	263	8.7	19	1.9	528	12.8	17.8
CIP392244.3	85	59	4	4	32.4	4	454	3.3	302	10.8	26	2.7	782	20.8	28.9
Desiree (ch)	100	48	3	3	29.4	4	166	1.3	209	7.4	30	3.2	405	11.9	16.5
K. Jyoti (ch)	100	55	4	4	33.0	4	195	1.8	279	12.5	51	6.6	526	20.9	29.1
Mean															21.0
F-Test															**
LSD (0.05)															5.21

At ARS Pakhribas, seven potato genotypes were tested along with Desiree, K. Jyoti and Local varieties (Table 1.5). The plant emergence was highest (98%) in PRP55861.6 followed by CIP388676.1 (96%) and the lowest (83%) in CIP394034.65. The ground cover was highest (99%) in PRP55861.6 and the lowest (36%) in CIP377957.5. The highest (5) number of main stems per plant was in CIP377957.5. The tallest (50 cm) plants were measured in PRP55861.6 (50 cm) and the shortest (20 cm) was in CIP377957.5 All the tested clones were found susceptible to late blight disease in the trial.

With respect to tuber size distribution, the number undersized tuber was highest in MS35.9 (328) and weight in CIP377957.5 (3.7 kg). But the number and weight of seedsized tuber were produced the highest in Local (127) variety and K. Jyoti (6.1 kg). Likewise, the number and weight of oversized tuber was maximum in PRP35861.18 (64 and 7.3, respectively). The total number and weight of tubers per plot was harvested highest in MS35.9 (390) and PRP35861.18 (15.7 kg), respectively. Yield variation among the clones was highly significant (<0.001). The highest (21.8 t/ha) yield was recorded in PRP35861.18 and the lowest (6.3 t/ha) was in CIP394034.65. PRP35861.18 and PRP55861.6 are selected for farmer's field trial whereas MS35.9, CIP392228.66, and CIP394034.65 are rejected from CVTs and remaining clones are recommended to re-test for next year at the same research station.

Table 1.5: Plant and yield characters of potato clones tested in CVT at ARS Pakhribas, 2069/70

Clones	Emg (%)	Ground cover (%)	Stem/ pt (no.)	Plant ht. (cm)	LB score (1-9)	Tuber size distribution (No and % Wt.)						Total tuber/plot		Adj yield (t/ha)
						US		SS		OS				
						No	Wt	No	Wt	No	Wt	No	Wt (kg)	
PRP55861.6	98	99	3	50	7	226	3.2	120	4.5	25	1.8	371	9.9	13.7
MS35.9	92	68	4	41	7	328	3.4	59	2.3	3	0.3	390	6.5	9.1
PRP35861.18	92	86	3	45	6	68	1.3	116	5.8	64	7.3	249	15.7	21.8
CIP392228.66	88	38	4	23	7	263	3.0	50	1.8	0	0	313	5.5	7.7
CIP394034.65	83	43	3	30	6	128	2.0	48	1.7	0	0	177	4.5	6.3
CIP388676.1	96	55	4	37	7	139	2.3	121	4.7	17	1.6	277	8.9	12.3
CIP377957.5	90	36	5	20	5	316	3.7	42	1.4	3	0.2	360	5.8	8.0
Desiree (ch)	85	44	3	28	6	90	1.8	60	2.6	4	0.4	154	5.7	7.9
K. Jyoti (ch)	92	74	3	38	7	141	2.4	125	6.1	37	3.4	303	13.2	18.3
Local (ch)	85	86	4	48	7	171	2.5	127	5.2	21	1.6	318	10.8	15.0
Mean														12.0
F-Test														**
LSD (0.05)														4.1

Nine potato genotypes were compared with Desiree, K. Sindhuri, Lal Gulab and K. Jyoti at Regional Agriculture Research Station, Nepalgunj (Table 1.6). The plant emergence was highest (99%) in CIP396311.1 and the lowest (85%) in CIP397073.15. The plant uniformity varied from 1 to 2 in 1-5 scale in all the clones tested. The ground foliage was highest (65%) in CIP395195.7 and the lowest (31%) in Desiree. Likewise, the plant height was maximum (62 cm) in PRP35861.13 and the minimum (28 cm) in CIP388676.1 and Desiree. The genotypes CIP388676.1 (3), CIP399101.1 (3), CIP397073.15 (3), CIP395195.7 (3), CIP396311.1 (3), Lal Gulab (3) and Kufri Sindhuri (4) were tolerant to late blight disease while remaining clones were found susceptible. CIP380606.6 produced the highest (4) number of main stems per plant while in others, it ranged from 2 to 3.

Regarding tuber size distribution, the highest number (158) and weight (2.1 kg) of undersized tubers were recorded in CIP380606.6. The maximum number (256) of seed sized tuber was produced in CIP380606.6 but the maximum weight was in CIP399101.1 (12.5 kg). The highest number and weight of oversized tuber production were occurred in CIP396311.1 (81 and 13.8 kg, respectively) and the lowest number (6) and weight (0.6 kg) were in PRP225861.2. CIP380606.6 gave the maximum number (427) of tuber per plot but the maximum weight (23.4 kg) was in CIP396311.1 followed by CIP395195.7 (23 kg). Yield obtained was highly significant among the tested clones. CIP396311.1 gave the highest (29.2 t/ha) yield followed by CIP395195.7 (32 t/ha) and the least (10.9 t/ha) by Desiree. CIP388676.1 and CIP380606.6 are selected for coordinated farmer's field trial whereas PRP225861.2 and PRP225861.5 were rejected from variety testing, and remaining clones are recommended to evaluate one year more at the same research station.

Table 1.6: Plant and yield characters of potato clones tested in CVT at RARS Nepalgunj, 2069/70

Genotypes	Emg. (%)	Plan unif (1-5	Groun cover (%)	Plan ht (cm	LB disease (1-9)	Stem/ Plant (no.)	Tuber size distribution (no. and wt., kg)						Total tuber/plot (no.)	Total wt./plot (kg)	Total yield (t/ha)
							US		SS		OS				
							No.	Wt.	No.	Wt.	No.	Wt.			
CIP388676.1	97	1	43	28	3	3	56	0.6	149	10.1	39	6.7	244	17.8	24.8
PRP225861.2	92	2	38	32	5	3	87	1.0	177	8.6	6	0.6	270	10.5	14.6
CIP380606.6	96	1	44	35	5	4	158	2.1	256	12.0	13	1.8	427	16.0	22.3
PRP225261.5	98	2	36	34	9	3	67	0.8	136	7.1	9	1.2	212	9.3	12.9
CIP397012.22	97	1	44	34	5	3	119	1.5	184	9.5	22	2.5	325	13.7	19.0
CIP399101.1	95	1	51	51	3	2	74	1.1	179	12.5	44	7.3	296	21.0	29.2
CIP397073.15	85	2	39	40	3	2	46	1.1	105	9.2	20	3.3	171	14.1	16.6
CIP395195.7	94	1	65	58	3	3	31	0.5	160	10.9	64	11.7	254	23.0	32.0
CIP396311.1	99	1	59	31	3	3	41	0.8	112	8.8	81	13.8	234	23.4	32.4
PRP35861.13	97	2	50	62	7	2	44	0.7	125	6.8	10	1.3	179	9.1	12.6
Desiree (ch)	96	3	31	28	8	2	50	0.9	88	5.9	7	0.9	145	7.9	10.9
K. Sindhuri (ch)	93	2	36	40	4	3	153	1.7	179	8.2	9	0.9	341	11.2	15.6
Lal Gulab (ch)	91	2	45	36	3	2	153	1.8	167	8.7	24	3.3	344	14.3	19.9
K. Jyoti (ch)	95	2	51	37	5	3	65	0.9	159	8.6	11	1.8	235	11.7	16.3
Mean															20.1
F Test															**
LSD (0.05)															4.7

At RARS Tarahara, nine potato genotypes were tested and compared with Desiree, K. Sindhuri and Farmer's Local as check varieties (Table 1.7). The highest (98%) emergence was recorded in CIP388676.1 and the lowest (83%) was in K. Sindhuri and Farmers Local. The plant uniformity was highest (5) in PRP225861.2 and the lowest (2) was in Farmers' Local. The ground foliage produced the highest (100%) in CIP388676.1 and CIP396311.1 and the lowest (73%) in CIP399101.1. The plant height was highest (68.8 cm) in CIP380606.6 followed by Desiree (65.1 cm) and the lowest (50.7 cm) in K. Sindhuri. Clone CIP397012.22 gave more number of main stems per plant followed by PRP35861.13. The genotypes tolerant to late blight disease in this year were Desiree (4), K. Sindhuri and Farmer's local (4) but all the tested clones were found resistant to late blight in eastern terai condition.

The number and weight of undersize tubers were recorded the highest in Farmers local and values were 432 and 4.3 kg, respectively. But the number of seed sized tuber and weight were the highest in CIP380606.6 (182) and PRP225861.5 (8.2 kg), respectively. Similarly, the largest number (59) and weight (10.9 kg) of oversized tubers were occurred in CIP395195.7. CIP380606.6 yielded the maximum (483) number of tuber per plot whereas the maximum weight (22.0 kg) was yielded by CIP395195.7. Variation on yield among the genotypes was significant (<0.05). The clone CIP395195.7 produced the highest yield (30.7 t/ha) followed by CIP388676.1.

The lowest (13.1 t/ha) yield was in K. Sindhuri, one of the check varieties. Based on two year's results, clones CIP388676.1, CIP380606.6, PRP225861.2, PRP35861.13 and PRP225861.5 are selected for farmer's field trial and remaining clones will be re-tested in next year at the same research station.

Table 1.7: Plant and yield characters of potato clones in CVT at RARS Tarahara, 2069/70

Genotypes	Emg. (%)	Plant unif. (1-5)	Ground cover (%)	Plant ht. (cm)	Stem/ Plant (no.)	LB disease (1-9)	Tuber size distribution (no. and wt., kg)						Total tuber/plot (no.)	Total wt./plot (kg)	Total yield (t/ha)
							US		SS		OS				
							No.	Wt.	No.	Wt.	No.	Wt.			
CIP388676.1	98	4	100	62.3	5	1	147	3.3	82	6.3	55	10.1	284	19.9	27.7
CIP380606.6	96	4	87	68.8	4	1	279	3.1	182	7.1	23	2.1	483	12.8	17.8
CIP395195.7	94	3	87	64.8	4	2	71	1.9	96	7.9	59	10.9	226	22.0	30.7
CIP397012.2	96	4	90	62.2	6	2	99	2.5	160	7.3	30	3.5	290	13.8	19.2
PRP225861.2	96	5	90	53.2	4	1	162	3.5	115	7.2	32	3.7	310	15.0	20.8
PRP35861.13	94	4	83	58.9	5	1	114	2.9	88	5.7	27	3.3	229	12.6	17.5
PRP225861.5	96	4	97	61.5	4	2	216	3.7	106	8.2	23	3.2	345	15.8	22.1
CIP399101.1	94	4	73	51.4	4	1	100	2.1	143	7.8	42	5.6	285	16.6	23.1
CIP396311.1	94	4	100	61.7	4	1	64	1.1	96	6.9	54	8.1	213	17.0	23.7
Desiree (ch)	90	3	80	65.1	4	4	97	2.2	84	6.1	41	6.1	222	16.4	22.8
K. Sindhuri (ch)	83	3	87	50.7	3	4	167	2.1	76	4.5	13	1.2	256	9.4	13.1
Farmers Local (ch)	83	2	83	63.7	4	4	432	4.3	85	4.0	15	1.4	532	10.9	15.2
Mean															21.1
F Test															*
LSD (0.05)															10.7

3.1.1.3 Coordinated farmers field trials (CFFTs)

Clones selected from CVTs were tested as CFFTs in different outreach research sites of the respective research station throughout the country. In addition, NPRP also conducted some on-farm trials in its own initative. The most important plant and yield parameters, farmers' feedback on the plant and tuber appearance, foliage characteristics and taste of assessed clones in comparison to the existing popular varieties from respective locations are obtained in the CFFTs. The highly preferred clones in CFFTs are further verified under farmers' field conditions as farmer's acceptance tests (FATs) prior to release as the commercial varieties.

In all locations, plots consisted of four rows, each row with 12 tubers. Row to row and plant to plant spacing was maintained at 60 x 25 cm. The trials were designed as RCBD with four replications. Plots were fertilized at the rate of 100:100:60 kg NPK and 20 tons FYM per hector as basal dose in furrow. The seed tuber size was ranged from 25 to 50 g in all the experiments. All other cultural practices were followed as per NPRP recommendations.

The data collected were:

Growth parameters

1. Emergence (%) at 15 and 30 days after planting in winter season trial and 30 and 45 days in summer season trials
2. Plant height (average of 5plants/clone in each replication)
3. Plant uniformity (after 6 weeks of planting at 1-5 scale)
4. Plant vigor (after 6 weeks of planting at 1-5 scale)
5. Number of main stems per plant (average of 5 plants in each replications), and
6. Late blight rating (using 1-9 scale)

Yield and Yield parameters

1. Number of plants harvested
2. Number and weight fraction of the tubers in three grades (small, medium and large)
3. Total number and weight of tubers/plot
4. Yield tons per hectare
5. Farmers' reaction
5. Color, shape and eye depth of the tubers

At one of the outreach research site of ARS Pakhribas, a coordinated farmers field trial was conducted to evaluate seven varieties (Table 1.8). The plant emergence was highest (100 %) in CIP393385.39 and the lowest (86%) in Local check. Likewise, the ground cover was highest (92%) in CIP394050.110, and the lowest (41%) was in Desiree. The plant height was the tallest (44 cm) in CIP394050.110 and Local variety and the lowest (22 cm) in Desiree. The number of main stems per plant was highest (4) in CIP394050.110 and CIP393385.39. CIP394050.110, CIP389746.2, and CIP393385.39 were highly resistant (1 in 1 to 9 scale) to late blight whereas others genotypes in the evaulation were found tolerant.

The highest number (308) and weight (4.1 kg) of undersized tuber were recorded in CIP394050.110. But the number and weight of seed sized tubers were the highest (164 and 6.5 kg, respectively) in CIP393385.39. Likewise, the highest number (23) and weight (2.5 kg) of oversized tuber were recorded in CIP389746.2. The highest number and weight of total tuber were produced in CIP394050.110 (437) and CIP393385.39 (10.5 kg) and CIP385499.11 (10.5 kg), respectively but the lowest number (110) and weight (2.3 kg) were produced in Desiree. Yield variation was found highly significant (<0.001) among the clones. The greatest yield (14.6 t/ha) was recorded in CIP393385.39 and CIP385499.11 and the lowest (3.2 t/ha) in Desiree. Based on two year's data comparison, CIP393385.39 and CIP385499.11 and CIP389746.2 are selected for farmer's accpetance tests (FATs) whereas the

remaining clones are recommended to re-test one year more at the same outreach sites.

Table 1.8: Plant and yield characters of potato clones tested at CFFT, ARS Pakhribas, 2069/70

Clones	Em (%)	Ground cover (%)	Plant height (cm)	Stem/ plant (no.)	LB score (1-9)	Tuber size distribution (No. and % Wt.)						Total tuber/plot		Adj yield (t/ha)
						US		SS		OS				
						No.	Wt	No.	Wt	No.	Wt.	No.	Wt (kg)	
CIP394050.110	97	92	44	4	1	308	4.1	128	3.9	1	0.1	437	8.4	11.7
CIP389746.2	96	75	36	2	1	66	1.1	60	2.7	23	2.5	149	6.5	9.0
CIP393385.39	100	85	37	4	1	221	2.3	164	6.5	19	1.7	405	10.5	14.6
CIP385499.11	95	78	37	3	3	138	1.9	149	6.1	19	2.0	306	10.5	14.6
Desiree (ch)	98	41	22	2	3	78	1.0	31	1.0	1	0.1	110	2.3	3.2
K. Jyoti (ch)	98	54	28	3	4	136	1.9	109	4.3	3	0.2	248	6.6	9.2
Local (ch)	86	86	44	3	3	98	1.5	65	2.9	10	0.7	173	5.9	8.2
Mean														10.0
F-Test														**
LSD (0.05)														3.58

At the outreach research sites of RARS Doti, four highly promising potato clones were tested and compared with Desiree, Kufri Jyoti and Farmers' local (Table 1.9). The highest (92%) ground cover was recorded in PRP85861.8 whereas the lowest (48%) in Kufri Jyoti. Clone PRP85861.11 had the highest (86%) percentage of ground cover and the lowest (59%) in K. Jyoti. CIP389746.2 had the tallest (48 cm) plants whereas Farmers' local had the shortest (26 cm) plant. The average number of main stems per plant varied from 3 to 4 in number among the tested clones.

The largest number (202) and weight (2.1 kg) of undersized tubers were recorded in Farmer's Local whereas the seedsized number and weight were highest (155 and 5.7 kg, respectively) in PRP85861.11. The highest number and weight of oversized tubers per plot were 91 and 6.8 kg in CIP389746.2, respectively. CIP393206.35 had the highest number of tubers per plot whereas the highest weight per plot was in PRP85861.11 (13.3 kg). The average tuber yield per hectare was highest (18.4 t/ha) in PRP85861.11 followed by CIP389746.2 (16.5 t/ha), CIP393206.35 (16.1 t/ha) and PRP85861.8 (15.0 t/ha), respectively. Farmer's local variety yielded the lowest yield (10.6 t/ha) followed by Kufri Jyoti (10.9 t/ha). Clones PRP85861.11, CIP389746.2 and PRP85861.8 are promoted for farmer's acceptance tests (FATs) whereas the remaining clones are recommended to place the farmer's field trial one year more to verify the result.

Table 1.9: Plant and yield characters of potato clones tested in CFFT at ARS Doti, 2069/70

Genotypes	Emg. (%)	Ground cover (%)	Plant ht. (cm)	Stem/ Plant (no.)	Tuber size distribution (no. and wt., kg)						Total tuber/plot (no.)	Total wt./plot (kg)	Total yield (t/ha)
					US		SS		OS				
					No	Wt.	No.	Wt.	No.	Wt.			
PRP85861.11	85	86	34	4	109	1.4	155	5.7	85	6.0	349	13.3	18.4
CIP389746.2	82	70	48	4	118	1.4	85	3.3	91	6.8	294	11.9	16.5
PRP85861.8	92	71	43	4	109	1.3	138	5.4	59	3.9	306	10.8	15.0
CIP393385.39	82	64	41	4	143	1.7	79	3.2	61	4.7	283	9.7	13.5
CIP393206.35	81	78	35	3	171	2.0	140	5.2	66	4.2	377	11.6	16.1
Desiree	89	70	34	3	82	1.0	92	3.5	69	5.1	243	9.8	13.7
K. Jyoti	48	59	30	3	58	0.7	96	3.2	56	3.7	210	7.9	10.9
F. Local	80	64	26	3	202	2.1	101	3.9	11	0.6	314	7.6	10.6
Mean													14.3
F Test													**
LSD (0.05)													3.8

At Nayagaon, Surkhet, four advanced potato clones were evaluated along with Janak Dev (Table 1.10). The distribution of tuber among the tested clones varied considerably. The clone PRP25861.11 yielded more (101) number of undersized tubers whereas the highest (1.4 kg) weight was recorded in PRP276264.1.

Table 1.10: Plant and yield characters of potato clones tested in CFFT at Naya Gaon, Surkhet, 2069/70

Genotypes	Tuber size distribution (no. and wt., kg)						Total tuber/plot (no.)	Adj. total wt./plot (kg)	Adj. yield (t/ha)
	US		SS		OS				
	No.	Wt.	No.	Wt.	No.	Wt.			
PRP225861.2	80	1.1	91	2.1	31	2.3	202	7.3	20.4
PRP276264.1	99	1.4	100	3.3	42	3.0	241	9.2	25.7
PRP266264.15	88	1.0	93	2.2	45	3.3	226	7.1	19.7
PRP25861.11	101	1.2	120	2.5	50	2.5	271	6.2	17.2
Janak Dev (ch)	76	0.9	80	1.9	33	2.2	189	7.5	20.8

The highest number and weight of seed sized tubers were produced in PRP25861.11 (120) and PRP276264.1 (3.3 kg), respectively. But the highest number and weight of oversized tuber were produced in PRP25861.11 (50) and PRP266264.15 (3.3 kg), respectively. Total number and weight of tuber per plot were produced the highest in PRP25861.11 (271) and PRP276264.1 (9.2 kg), respectively. PRP276264.15 gave the highest (25.7 t/ha) tuber yield and the lowest (17.2 t/ha) was in PRP25861.11.

In the command areas of RARS Nepalgunj Banke, four different promising potato clones were tested and compared with Desiree, Kufri Sindhuri, Kufri Jyoti and farmers' local (Table 1.11). The plant emergence in the trial ranged from 89% in MS35.9 to 99% in Desiree and Farmer's Local. The plant uniformity remained poor ranging from 1 to 2 in 1 to 5 scales. Percentage ground cover was recorded the highest (64) in farmers' local and the lowest (49) was L235-4. Plants of MS 35.9 were the tallest (48 cm) and the shortest (36 cm) was in Kufri Jyoti. Farmers' local

had the highest number (4) of main stems per plant. Late blight severity was the highest (6) in 1 to 9 scales in CIP 393077.15 whereas the lowest (2) was in L235-4 and CIP384321.15.

Table 1.11: Plant and yield characters of potato clones in CFFT at RARS Nepalgunj, 2069/70

Genotypes	Emg (%)	Unif (1-5)	Ground Cover (%)	Plant ht (cm)	Stem/ Plant (no.)	LB Score (1-9)	Tuber size distribution (no. and wt., kg)						Total tuber/plot (no.)	Total wt./plot (kg)	Total yield (t/ha)
							US		SS		OS				
							No	Wt	No	Wt	No	Wt			
CIP384321.15	97	2	63	38	3	2	131	2.0	259	14.0	20	2.5	410	18.5	26.7
MS35.9	89	2	53	48	3	3	113	1.3	224	11.6	32	4.5	369	17.4	24.6
CIP393077.159	95	1	63	46	3	6	46	0.3	134	8.8	48	8.4	228	17.4	24.4
L235-4	98	1	49	39	3	2	148	1.8	283	15.5	19	2.7	450	19.9	27.9
Desiree	99	2	59	37	2	3	44	0.8	116	6.5	31	4.5	191	11.8	16.7
K. Sindhuri	98	2	60	40	2	3	177	1.8	188	8.5	16	2.2	381	12.4	17.3
K. Jyoti	92	2	61	36	2	3	134	1.8	169	8.7	16	2.3	318	12.7	17.9
Farmers Local	99	2	64	42	4	3	64	1.0	219	11.7	16	2.0	299	14.7	20.5
Mean															21.9
F Test															**
LSD (0.05)															5.9

The number and weight of undersized tuber produced the maximum in Kufri Sindhuri (177) and CIP384321.15 (2.0 kg), respectively. But the largest number (283) and weight (15.5 kg) of seedsized tubers were produced in L235-4. Clone CIP393077.159 gave the highest (48) number and weight (8.4 kg) of oversized tubers. Total number of tubers and weight per plot were counted the highest (450) in L235-4 followed by CIP384321.15 (410 and 19.9 kg, respectively). The tuber yield was obtained the highest (27.9 t/ha) from L235-4 followed by CIP 384321.15 (26.7 t/ha). Based on this evaluation, all the tested clones will be repeated at the same research sites of RARS Nepalgunj one year more.

Clones CIP392206.35, PRP85861.11, PRP85861.12 and L235-4 were tested and compared with varieties Desiree, Kufri Jyoti and Farmers' local in the command areas of RARS Tarahara, Sunsari (Table 1.12). Highest (100%) plant emergence was recorded in PRP85861.11 and L235-4. The plant uniformity was very high (5) in Kufri Jyoti whereas it was low (3) in farmers' local and Desiree. L235-4 had the highest (98%) percent ground cover among the tested clones. The plants of Kufri Jyoti were tallest (57 cm) and then in CIP 392206.35 (54 cm) and PRP85861.11 (50 cm). Average number of main stems remained 3 to 4. PRP85861.12 was observed highly resistant to late blight but genotypes susceptible to late blight were farmers' local (6) and Desiree (5). The maximum (334) number and weight (5.5 kg) of undersized tuber were produced in Kufri Jyoti and L235-4, respectively. Similarly, the greatest number and weight of seedsized tuber were produced in PRP85861.12 (324) and L235-4 (10.0 kg), respectively. The greatest number (60) and weight (7.0

kg) of oversized tuber were produced in PRP85861.11 and L235-4, respectively. Clone L235-4 was the most superior genotype on producing highest number of the tubers (526) and total weight (22.5 kg) per plot. Yield was significantly (<0.05) different among the clones. L235-4 gave more yield (31.2 t/ha) as compared to check varieties. Kufri Jyoti yielded better (21.1 t/ha) than farmers' local (20.1 t/ha) and the lowest (15.1 t/ha) was recorded in CIP392206.35. From this varietal evaluation, CIP392206.35 is discarded and the remaining clones will be re-tested at the same research command sites of RARS, Tarahara.

Table 1.12: Plant and yield characters of potato clones in CFFT at RARS Tarahara, 2069/70

Genotypes	Emg (%)	Unif (1-5)	Ground cover (%)	Plant ht (cm)	Stem/ Plant (no.)	LB Score (1-9)	Tuber size distribution (no. and wt., kg)						Total tuber/plot (no.)	Total wt./plot (kg)	Adj yield (t/ha)
							US		SS		OS				
							No.	Wt.	No.	Wt.	No.	Wt.			
CIP392206.35	98	4	80	54	3	2	109	2.5	69	4.1	32	4.0	210	10.8	15.1
PRP85861.11	100	4	91	50	3	3	218	3.3	143	7.9	60	6.9	420	18.4	25.5
PRP85861.12	98	4	93	49	4	1	286	3.3	324	4.8	57	4.5	66	12.8	17.9
L235-4	100	4	98	49	4	3	280	5.5	197	10.8	49	7.0	526	22.5	31.2
Desiree	96	3	74	47	3	5	180	3.8	116	7.2	44	6.4	340	18.2	25.2
K. Jyoti	98	5	93	57	4	4	334	3.2	137	5.9	46	5.8	517	15.2	21.1
F. Local	90	3	73	47	4	6	275	4.2	91	5.2	34	3.7	400	14.5	20.1
Mean															22.3
F-Test															*
LSD (0.05)															9.2

At Nigaley, Sindhupalchowk, one of the research sites of NPRP, five potato genotypes were evaluated along with the check varieties; K. Jyoti, Janak Dev, and Rosita for their plant and yield characters (Table 1.13). The plant emergence was observed the highest (95%) in MS35.9 and K. Jyoti followed by PRP35861.18 (94%) and Janak Dev (94%). The ground cover was highest (96%) in PRP25861.1 followed by Rosita (95%). The plant uniformity was highest (5) in PRP25861.1 and Rosita. PRP25861.1 had the highest (53 cm) plant height and the lowest (22 cm) was in CIP389746.2. The average number of main stems per plant varied from 2 to 4 in the tested clones.

With regard to tuber size distribution, the number and weight of undersized tuber were occurred the highest in MS35.9 (61) and PRP25861.1 (0.8 kg), respectively. In contrast, the highest number (177) and weight (9.7 kg) of seed sized tuber was produced in K. Jyoti. However, PRP25861.1 yielded the maximum (46) number and weight (7.2 kg) of oversized tubers. Total number and weight of total tubers per plot were the highest in Kufri Jyoti (237) and PRP25861.1 (17.9 kg), respectively. Yield differed significantly (<0.05) among the tested clones in the trial. The highest yield (24.9 t/ha) was recorded in PRP25861.1 followed by K. Jyoti (20.4 t/ha), a check variety and the lowest (7.9 t/ha) yield was in MS35.9. Based on the results of two year's, PRP25861.1 is selected for famer's acceptance tests (FATs). Clone CIP394050.110 is discarded from the trial while the remaining clones are

recommended to repeat at the same outreach sites of NPRP. Khumaltar for one year more.

Table 1.13: Plant and yield characters of potato clones tested at CFFT Nigaley, 2069/70

Clones	Emg (%)	Ground cover (%)	Unif (1-5)	Plant ht (cm)	Stem/ plant (no.)	Tuber size distribution (# & wt.,kg)						Total tuber/plot		Adj yield (t/ha)
						US		SS		OS				
						No	Wt.	No	Wt.	No	Wt.	No	Wt.(kg)	
CIP386074o.2	72	2o	3	22	2	2o	0.3	74	3.5	15	2.1	109	8.2	11.4
PRP158o1.18	94	52	4	43	3	2o	0.5	105	5.3	22	4.1	156	10.6	14.7
CIP394050.110	75	41	3	35	4	37	0.5	100	4.8	13	1.7	150	9.7	13.4
PRP258o1.1	8o	9o	5	53	4	45	0.8	135	7.7	4o	7.2	226	17.9	24.9
MS35.9	95	31	3	29	4	6l	0.7	70	2.8	19	2.1	150	5.7	7.9
K. Jyoti (ch)	95	53	4	4o	4	3o	0.5	177	9.7	25	3.7	237	14.7	20.4
Janak Dev (ch)	94	84	4	4o	3	24	0.4	109	6.4	31	4.6	164	11.6	16.1
Rosita (ch)	85	95	5	48	4	47	0.6	160	7.8	29	3.7	235	14.4	19.9
Mean														16.1
F-Test														*
LSD (0.05)														8.98

3.1.2 True Potato Seed (TPS) Research

3.1.2.1 Evaluation of TPS F_1C_2 tuberlets production in the farmers' fields

Introduction

The major objectives were to identify the suitable TPS F_1C_2 progenies with good uniformity, shape and resistant to pest and diseases and high productivity; to evaluate the parental lines and recommend TPS families for central mid hill and Terai.

Materials and Methods

F_1C_1 tuberlets produced from previous years were planted in the farmers' fields in Sharadhanagar VDC-3 of Chitwan and Kusadevi VDC-7 of Kavrepalanchok districts. Three farmers namely Mr. Chet Prasad Humagain, Mrs. Januka Sapkota and Mr. Badri Acharya in Kusadevi and Mr.Chandra Nath Ghimire, Mrs. Sitadevi Ghimire and Mr. Babu Ram Regmi in Sharadhanagar were selected for experiment. Eight hybrid TPS F_1C_2 families were planted where Janakdev was used as the check variety. Based on the on -station performance, selected genotypes tested in farmer's field condition. Plot size was 2.4 m x 3 m. TPS families were sown in RCBD with three replications; a farmer is treated as a replication. Potato tuberlets were planted by maintaining row- to- row 60 cm and plant-to-plant 25 cm distance. Fertilizer was used at the rate 100:100:60 NPK kg/ha with 20 t FYM/ha. No fungicide and insecticide sprayed and other management practices were followed as per NPRP recommendation. Growth parameters and total tuber yield and yield attributing characteristics were recorded during study.

Results and Discussion

Chitwan

The plant emergence was recorded from lowest (41.67) to highest (48) in tested genotypes. The ground coverage was highest (80%) and good plant uniformity (5) in LT 8×TPS-67. The maximum number of stems per plant (4.6) was recorded in the family MF II x TPS -67 followed by LT 8 x TPS-67 (4.5) (Table 2.1). The maximum plant height (74.7 cm) was observed in the family HPS II/67 where as the minimum (53.2 cm) in the family HPS 7/67. TPS family HPS7/67 produced the maximum numbers of tubers (429) per plot and LT 8×TPS-67 produced highest tuber yield (15.37 kg/plot). The minimum numbers (242) and tuber yield (9.77 kg) per plot was recorded in Janak Dev treated as a check variety. The tuber numbers per plot among the genotypes were statistically significant whereas yield was not significant.

Table 2.1: Evaluation of TPS F1C2 tuberlets production at Sharadhanagar VDC-3, Chitwan, 2069/70

Treatments	Emerg (%)	G.Coverage (%)	Uniformity (1-5)	Stem /plant (no.)	Plant ht (cm)	LB score (1-9)	Tuber yield / plot	
							No	Yield (kg)
HPS II/67	47.67	76.7	4.6	3.1	74.7	3	362.3	15.27
HPS 7/67	47.67	78.3	4.6	4.3	53.2	3	429.0	14.47
C96H-13.29×TPS-13	46.67	78.3	4.3	2.6	64.6	4	295.7	14.63
C96H-02.4×C98HT-64.8	41.67	70.0	3.0	2.4	67.4	2	270.3	14.83
C96H-02.4×C99HT-2-32.17	44.33	71.7	3.6	4.0	56.7	3	342.7	14.17
LT 8×TPS-13	47.67	76.7	4.6	4.2	57.5	4	353.3	14.90
LT 8×TPS-67	48.00	80.0	5.0	4.5	60.2	4	397.7	15.37
MF II×TPS-67	47.00	73.3	4.3	4.6	55.5	4	369.3	13.47
Janakdev	44.67	75.0	4.0	3.3	63.6	4	242.0	9.77
F-value							0.006	0.213
LSD(0.05)							86.43	4.132
CV %							14.7	16.9

Kavrepalanchok

The plant emergence was recorded from 45.33 to 48 in evaluated genotypes. The ground cover was highest (90%) in LT 8×TPS-13 and lowest (70%) in C96H-02.4×C99HT-2-32.17 was recorded. The plant uniformity remained in between 4 to 4.5 out of 1-5 scales in most of the genotypes. Maximum(9.2) number of stems per plant was found in HPS 7/67. The highest (65.7 cm) plant height was measured in LT 8×TPS-13 and the lowest (44.4 cm) in C98HT-200.14×C99HT-2-58.1. All genotypes were found resistance to late blight disease to this season in evaluated domain. The maximum (822) number of tubers per plot was counted in HPS 7/67 followed by C96H-13.29×TPS-13 (768). But the highest (22.67kg) tuber weight per plot was obtained in LT 8×TPS-13 followed by LT 8×TPS-67 (22.10kg). The tuber number per plot varied significantly among the evaluated genotypes but weight was statistically not significant (Table 2.2).

Table 2.2: Evaluation of TPS F1C2 tuberlets production at Kusadevi VDC-7, Kavrepalanchok, 2069/70

Treatments	Emerg. (%)	G.Coverage (%)	Uniformity (1-5)	Stem /plant (no.)	Plant ht (cm)	Late blight (1-9)	Tuber yield / plot	
							No	Yield (kg)
C96H-02.7×TPS-13	47.00	78.3	4.3	5.3	64.6	1	552	19.97
C98HT-200.14×C99HT-2-58.1	47.00	75.0	3.3	5.8	44.4	1	549	18.53
LT 8×TPS-67	47.00	85.0	4.3	6.4	54.1	1	762	22.10
C96H-13.29×TPS-13	46.33	86.7	4.6	5.7	56.0	1	768	21.43
MF II×TPS-67	46.00	78.3	4.0	7.2	51.7	1	645	19.23
LT 8×TPS-13	48.00	90.0	4.3	5.8	65.7	1	549	22.67
HPS 7/67	48.00	81.7	4.3	9.2	49.5	1	822	19.67
C96H-02.4×C99HT-2-32.17	45.67	70.0	3.3	5.4	46.6	1	464	13.57
Janakdev	45.33	80.0	4.0	5.3	58.3	1	402	19.80
F-value							0.003	0.232
LSD(0.05)							193.5	6.519
CV %							18.2	19.2

3.1.2.2 Evaluation of F_1C_1 tuberlets of TPS for potato production

Introduction

This experiment was conducted at NPRP, Khumaltar; RARS, Nepalganj, and ARS (Hort.) Rajikot, Jumla. The major objectives were to identify the suitable TPS progenies with good uniformity, shape and resistance to pest and diseases, and high productivity, to recommend TPS families for respective agro-ecological zones and to evaluate the parental lines and ware potato production.

Materials and Methods

This trial was conducted using tuberlets from previous year's nursery bed trial. Twelve TPS families were planted, where Kufri Jyoti, Janak Dev, Kufri Sindhuri, Pericolli and Jumla local were used as check varieties. Size of each plot was 3 m x 2.4 m (7.2 m^2). Seed tubers were planted on ridges by maintaining row to row 60 cm and plant to plant 25 cm distance. Fertilizer was used at the rate 100:100:60 NPK kg/ha with 20 t FYM/ha. Each TPS F_1C_1 generation was replicated three times. No fungicide was applied and other management practices were followed as per NPRP recommendation.

Results and Discussion

Khumaltar

Planting at Khumaltar was done in 3rd Feb, 2013 and harvesting was done in 12nd June, 2013. The plant emergence was highest in TPS 7×TPS-67 and MFII×TPS-67 among TPS tuberlets. Percent of ground coverage was the highest (86.67) on check variety Kufri Jyoti followed by TPS family LT8×TPS-67(85), but the lowest (71.67) was recorded in the TPS family C98HT-200.14×C99HT-2-58.1. The plant uniformity remained 3 to 4 (1-5 score) in most of the tested genotypes (Table 2.3). All the tested genotypes tested were found resistant to late blight disease in this testing site.

Table 2.3: Yield and yield attributing parameters in TPS F_1C_1 generation of potato at Khumaltar, 2069/70

Treatments	Emer-gence (%)	Ground covera ge (%)	Unifor mity (1-5)	Stem/ plant (no.)	Plant height (cm)	Tuber /plot/ (no.)	Tuber yld/plot (kg)
HPS II/67	47.33	75.00	3.0	3.9	52.27	366.3	11.80
C96H-02.4× C99HT-2-32.17	47.00	75.00	3.0	2.9	66.87	238.7	10.37
HPS 7/67	47.67	75.00	3.3	3.7	45.40	476.0	13.57
C96H-02.7× TPS-13	46.33	78.33	3.3	2.9	73.53	309.7	11.73
C98HT-200.14× C99HT-2-58.1	47.00	71.67	3.3	3.6	57.53	357.3	10.30
LT 8×TPS-67	47.00	85.00	4.0	4.5	56.67	581.0	19.57
C96H-02.4×C99HT-2-58.1	46.67	73.33	3.3	3.2	64.87	328.7	11.57
C96H-02.4×C98HT-64.8	46.67	80.00	3.6	3.3	71.73	464.7	16.87
LT 8×TPS-13	45.67	78.33	4.0	3.8	60.73	400.7	15.60
C96H-13.29×TPS-13	47.00	80.00	4.0	3.1	63.40	424.7	18.43
TPS 7×TPS-67	48.00	81.67	3.6	4.6	50.00	530.0	15.37
MF II×TPS-67	48.00	78.33	3.3	4.8	57.20	441.3	16.40
Kufri Jyoti	47.33	86.67	5.0	4.9	42.13	469.0	22.43
Janakdev	47.33	83.33	4.0	3.2	67.47	318.3	16.93
F-value						<.001	<.001
LSD(0.05)						100.9	4.013
CV %						14.8	15.9

Maximum plant height (73.53 cm) was recorded in C96H-02.7×TPS-13 followed by C96H-02.4×C98HT-64.8 (71.73 cm) and the lowest (42.13 cm) in check variety Kufri Jyoti. Maximum tuber per plot (581.0) was recorded in genotype LT 8×TPS-67 followed by TPS 7 x TPS-67 (530.0). In contrast, the total weight per plot was highest (22.43 kg) in check variety Kufri jyoti followed by LT 8 x TPS-67 (19.57 kg). But, family C96H-02.4 x C99HT-2-32.17 produced the minimum tubers (238.7). Both number of tubers and yield per plot were highly significant among the genotypes.

Nepalgunj

At RARS Nepalgunj, most of the genotypes showed plant emergence count below 40% at 30 days after planting (Table 2.4). The ground coverage (60%) was highest on C96H-02.4 x C99HT-2-32.17 followed by HPS 7/67 (58.3%).

Table 2.4: Yield and yield attributing parameters in TPS F_1C_1 generation of potato at Nepalgunj (2069/70)

Treatments	Emg (%)	Ground cover (%)	Unifor -mity (1-5)	Stems/ plant (no)	Plant height (cm)	LB score (1-9)	Tubers / plot (no.)	Tuber yield/plot (kg)
HPS II/67	37.7	41.6	1.3	2.0	33.2	2.3	264.3	12.43
LT 8×TPS-13	30.0	38.3	2.0	2.2	38.3	3.0	187.0	11.50
TPS 7×TPS67	47.0	45.0	2.0	2.3	30.7	2.6	324.3	14.57
C98HT-200.14× C99 HT-2-58.1	29.3	36.6	2.3	2.1	40.4	2.0	198.0	11.27
MFII×TPS-67	36.7	41.6	2.0	2.2	31.3	2.6	266.0	11.37
C96H-02.7× TPS-13	39.3	45.0	1.6	2.2	50.4	4.0	259.7	16.03
C96H-02.4×C99HT-2-58.1	32.0	51.6	2.0	2.0	45.2	3.6	222.0	13.57
C96H-02.4× C98HT-64.8	37.3	40.0	2.0	2.1	39.1	3.6	199.3	12.23
C96H-02.4× C99HT-2-32.17	36.3	60.0	1.0	2.3	50.1	3.3	278.7	16.77
HPS 7/67	39.3	58.3	1.0	2.4	38.2	2.6	354.7	17.13
LT 8×TPS-67	35.0	45.0	2.0	2.5	37.5	1.6	264.3	13.43
C96H-13.29× TPS-13	35.0	36.6	2.0	2.1	34.7	2.0	207.7	12.77
Kufri Sindhuri	45.7	48.3	1.6	5.4	38.4	2.3	476.0	18.40
Pericolli	46.0	40.0	3.3	5.4	48.5	6.0	386.3	20.00
F-value							<.001	0.003
LSD(0.05)							74.19	4.347
CV %							15.9	18.0

Plant uniformity (1-5 score) was remained 2 in most of the families. Maximum stems per plant (5.4) were in both check variety Kufri Sindhuri and Pericolli. Plants of C96H-02.7×TPS-13 were tallest (50.4 cm) followed by C96H-02.4 x C99HT-2-32.17 (50.1 cm). The shortest (30.7 cm) was on TPS 7×TPS-67. The check variety pericolli was found susceptible (6) to late blight disease in field condition. Maximum tubers (476.0) and yield (20.0 kg /plot) was recorded in Kufri Sindhuri and Pericholi respectively, but family LT 8×TPS-13 produced minimum tubers (187.0).The tuber number and yield per plot were found statistically significant.

3.1.3 Innovative Community-based Agricultural Development Initiatives for Increased Climate Resilience of People

Introduction

As one of the research collaborators of Agriculture Environment Research Division Khumaltar, NPRP participated in the studies on the innovative community-based agricultural development initiatives for increased climate resilience of the people project in Nepal.

3.1.3.1: Collection, maintenance and multiplication of pipeline clones and local cultivars of potato

Materials and Methods

It was undertaken at Hattiban Research Farm Khumaltar located in Lalitpur (1340 masl) and at Agriculture Research Station (Hort.) Malepatan, Pokhara (848 masl).

Results and Discussion

In the first year of the project, the highly popular local cultivars were collected from different parts of the country and stored at Khumaltar. This year all the tubers were multiplied at Hattiban Research Farm of NPRP Khumaltar and ARS (Hort.) Pokhara. Total of 658 kg from the harvest of pipeline improved potato varieties (Table 3.1) and 15 to 40 tubers each of following local cultivars (Table 3.2) was selected and was stored in Balaju cold store to use as the seed materials for next season trials.

Table 3.1: Improved pipeline and other clones multiplied at NPRP, 2069/70

1.	CIP389746.2	7.	Kufri Sindhuri	13.	CIP384321.15
2.	PRP85861.11	8.	Kufri Jyoti	14.	MS35.9
3.	PRP85861.8	9.	CIP392271.58	15.	CIP393077.159
4.	CIP393385.39	10.	PRP25861.10	16.	L235-4
5.	CIP392206.35	11.	PRP85861.12		
6.	Desiree	12.	PRP35861.18		

Table 3.2: Seed tuber stock of local cultivars stored in Balaju cold store Kathmandu, 2069/70

S.N.	Cultivars	S.N.	Cultivars	S.N.	Cultivars	S.N.	Cultivars
1.	Lanthe	22.	Kaleje Alu, Panchthar	43.	Gharaiya	64.	Kagbeni
2.	Saithy Sirha	23.	Local red	44.	Lal gulab Dhanusha	65.	Lalgulab Jhapa
3.	Jumli local	24.	Kagbeni red	45.	Rato ankhe	66.	Thakali red
4.	Nigaley red round	25.	Hollen Alu Dhankuta	46.	MS Panchthar	67.	Thoti kaili
5.	Halle red	26.	Namche Red	47.	Totange red	68.	Local white Jumla
6.	Panauti red dallo	27.	Farse red	48.	White long Dhankute	69.	Langthe
7.	Dhankute red	28.	Seto alu Morang	49.	Sisne long	70.	Biju local
8.	Local red	29.	Seto alu Morang	50.	Sinhali local	71.	Gajale
9.	Bengal Jyoti Saptari	30.	Local white Jumla	51.	Dandapakhar	72.	Kharidhunge local
10.	Solu alu	31.	Local red Jumla	52.	Kachchu dallo	73.	Langthe
11.	Local red Jubitha, Kalikot	32.	Jumli local, Jumla	53.	Agara, Siraha	74.	Sailunge local
12.	Koshi pari Siraha	33.	Champi red	54.	Tharu local	75.	Sailunge white
13.	Suryamukhi	34.	Gajale	55.	Kalo ankhe	76.	Nigale seto
14.	Hellan Saptari	35.	Kagbeni	56.	Pakhribase	77.	Sailung blue
15.	Local white Kalikote	36.	Rosita	57.	Red potato Morang	78.	Kine red
16.	Bhutange Alu Jhapa	37.	Chisapani 1	58.	Red alu, Kheruwa	79.	Tune local
17.	Local Red Bharta Kalikot	38.	Halle	59.	Kaalankhe alu, Morang	80.	Chisapani chakre
18.	White alu oblong type Pachthar	39.	Local white Kalikote	60.	Local white Kalikote	81.	Laprang seto
19.	British alu Panchthar	40.	Jhyale, Dhankuta	61.	Red oblong Panchthar	82.	Jiri local
20.	Beutex	41.	NPI T/0012	62.	Local ciraito	83.	Danda pakhar seto
21.	Jumli Local	42.	Namche red	63.	Bikashe rato	84.	Lapchin red

3.1.3.2 Participatory varietal evaluation (PVE) on potato

Materials and Methods

It was undertaken in different farmers' fields at out-reach research sites from terai and mid-hills during the fiscal year 2012/013.

Several sets of PVEs as field experiments were studied in farmers' fields at various outreach research sites of NARC research stations during the year 2012/13. Variety Kufri Jyoti, one of the major hill varieties from Nepal was kept as an improved check along with the farmers' local in terai. All other tested clones were selected from pipe line stocks of NPRP.

Experimental sites were the command areas of ARS Belachapi, Dhanusa, RARS Parwanipur, Bara, RARS Nepalgunj Banke, RARS Tarahara, Sunshari, RARS Bhairahawa, Rupendehi, RARS Doti and RARS Lumle, Kashki. Tubers were planted in the furrow at the distance of 60 cm row to row and 25 cm plant to plant spacing. Recommended dose of fertilizers 100:100:60 kg $NP_2O_5K_2O$ was applied in furrows, then FYM @ 20 t/ha. Nitrogen was applied through urea and diamonium phosphate, phosphorus through diamonium phosphate and potash through muriate of potash. Uncut potato tubers were planted in the furrows above FYM and prepared ridges. All other intercultural operations were carried out as per the NPRP recommendation. The crop was harvested at its full maturity. Seed tubers were selected from each germplasm was stored in the store.

All the intercultural operations were followed as per the NPRP recommendations. In PVE, the data gathered were plant emergence, percent ground cover, plant height, plant vigour, late blight disease severity, number of main stems per plant, total number and weight of the tubers per plot and tuber yield tons per hectare and farmers' impression as well. In the trials, the variety recommended for long day conditions was added as the check to assess their vegetative and yield performance in adverse climatic conditions.

The results obtained were statistically analyzed using Genstat software package and seed tubers selected from both of the locations were stored in Balaju Cold store Kathmandu to use as the seed for next season/year in the trials.

Results and Discussion

At ARS Belachapi, Dhanusha total of 6 pipeline clones were tested and compared against variety Kufri Jyoti, a highly poular variety in the hills of Nepal and farmers' local (Table 3.3). In the trial, the emergence rate differed significantly among the tested clones was non-significant, whereas the plant vigour ranged 3 to 4 in 1 to 5 scales. The clone PRP 85861.8 was found highly resistant (18%) and clone CIP

392271.58 was found highly susceptible (91%) to late blight disease. Variety Kufri Jyoti once known as late blight disease resistant one in the high hills and mid hills has broken its resistance. Plants of clone PRP 85861.12 were measured tallest (45 cm) followed by PRP 85861.8 (40 cm). Plants of Kufri Jyoti variety were medium tall (39 cm). There was not much differences observed in average number of main stems per plant, however, majority of the tested clones had slightly higher number of stems than in check variety.

Table 3.3: Plant characteristics and yield of potato genotypes tested at ARS Belachhapi, 2069/70

Genotypes	Emergence (%)	Plant vig. (1-5)	LB disease (%)	Plant ht. (cm)	Stem/ Plant (no.)	Tuber /plot (no.)	Total wt./plot (kg)	Total yield (t/ha)
PRP85861.8	90	4	18	40	2	422	12.1	16.8
PRP85861.12	95	4	32	45	2	583	11.3	15.7
CIP392206.35	93	3	75	36	3	508	13.0	18.1
CIP392271.58	90	3	91	36	3	589	6.9	9.6
PRP25861.10	84	3	37	23	2	480	10.8	15.0
L235-4	94	4	27	30	3	718	14.5	20.1
K Jyoti (hill check)	99	4	89	35	3	282	8.6	12.0
Farmers' Local (terai check)	90	3	27	35	2	437	9.1	12.7
Mean	92	3.5	49.4	34.9	2.5	502	10.8	15.0
F-Test	NS	**	**	*	NS	NS	NS	NS
LSD (0.05)	11.8	0.5	26.9	10.6	1.0	498.1	6.5	9.0

NS = not significant at $P<0.05$, * = Significant at $P<0.05$, ** = Significant at $P<0.01$.

Despite of statistically non-significant results, the highest number of tubers (718) and weight (14.5 kg) per plot were obtained in the clone L 235-4. Hill variety Kufri Jyoti produced lowest tuber number per plot, whereas clone CIP 392271.58 produced lowest yield (6.9 kg) per plot. The tuber yield was also obtained highest (20.1 t/ha) from the clone L 235-4 followed by CIP 392206.35 (18.1 t/ha). Though the results was statistically non-significant, hill variety Kufri Jyoti gave slightly lower yield compared to the farmers' local check from terai.

Another set of the trial was planted in the command area of RARS Parawanipur, Bara. Four different highly promising clones in terai were tested and compared with the variety Kufri Jyoti, Desiree, Kufri Sindhuri and Farmers' local (Table 3.4). The emergence of the farmers' local was poorer compared to other clones planted. Plant uniformity ranged 3 to 5 in 1 to 5 scale. The percent ground cover recorded highest (73%) in variety Kufri Sindhuri slightly above to the local check (72%). In other clones it remained 45 to 68%. The plants of clone MS 35-9 were measured tallest

(73 cm) among the clones tested followed by Desiree (72%). All other clones were medium type. Average number of main stems per plant was counted highest in the clones L 235-4, Kufri Jyoti and Desiree (5) and lowest (3) in CIP 384324.15 and MS 35.9.

Table 3.4: Plant characteristics and yield of potato genotypes tested at Parwanipur, Bara, 2069/70

Genotypes	Emg. (%)	Plant unif. (1-5)	Ground cover (%)	Plant ht. (cm)	Stem/ plant (no.)	Total tuber/plot (no.)	Total wt./plot (kg)	Total yield (t/ha)
PRP35861.18	98	3	45	56	4	59	15.1	20.9
CIP384324.15	100	4	50	57	3	56	9.6	13.4
MS35.9	100	5	68	73	3	68	11.2	15.6
L235-4	100	5	65	54	5	77	10.3	14.4
K. Jyoti (ch)	98	5	65	56	5	56	8.4	11.7
Desiree (ch)	98	4	55	72	4	52	9.9	13.8
K. Sindhuri (ch)	98	5	73	51	5	65	11.3	15.6
Farmers' Local (ch)	90	4	72	53	4	91	12.2	16.9
Mean	99.1	4.2	61.4	59	4.0	65.5	11.0	15.3
F-test	NS	NS	*	NS	NS	NS	NS	NS
LSD (0.05)	5.4	1.5	17.8	19.9	2.2	37.6	6.1	8.5

NS = not significant at $P<0.05$, * = Significant at $P<0.05$, ** = Significant at $P<0.01$.

Farmers' local had the highest and Desiree had the lowest (52) number of tubers per plot (91), whereas in Desiree the lowest (52). The clone PRP 35861.18 produced highest tuber weight (15.1 kg) per plot and Kufri Jyoti had the lowest (8.4 kg). Farmers' local had second highest tuber weight (12.2 kg) per plot. The highest tuber yield was obtained from the clone PRP 35861.18 (20.9 t/ha) followed by farmer's local (16.9 t/ha) respectively. The yield difference was statistically non-significant.

Another set of the experiment was conducted in the command areas of RARS Bhairahawa (Table 3.5). Except in variety Desiree (5), all other clones had plant uniformity of 4 in 1 to 5 scales. Ground cover of the variety Kufri Jyoti and farmers' local had the highest (80) and other clones it remained in between of 71 to 78. Plants of the clone L 235-4 were tallest (45 cm) and Desiree and PRP 85861.11 the shortest (33 cm). Average number of main stems per plant was counted 3 to 4 in all the clones tested in the field. The plants of farmers' local were highly susceptible scoring 6 and CIP 392271.58 resistant (2) in 1 to 9 scales.

Total number of tubers were counted the highest (418) in the clone L 235-4 and the lowest (149) in Desiree. The clone PRP 85861.11 produced highest tuber weight (12.7 kg) per plot and lowest (4.1 kg) in Desiree. The highest yield was also obtained from the clone PRP 85861.11 (17.7 t/ha) followed by CIP 392271.58 (13.9

t/ha) and L 235-4 (13.2 t/ha), respectively. The results were highly significant in the parameters like tuber number and weight per plot and tuber yield tons per hectare.

Table 3.5: Plant characteristics and yield of potato genotypes tested at Bhairahawa, 2069/70

Genotypes	Plant uniformity (1-5)	Ground cover (%)	Plant height (cm)	Stem/ plant (no.)	LB (1-9 scale)	Total tuber/plot (no.)	Total wt./plot (kg)	Total yield (t/ha)
PRP85861.11	4	76	33	4	3	407	12.7	17.7
CIP392271.58	4	78	45	4	2	280	10.0	13.9
L235-4	4	76	48	4	4	418	9.5	13.2
K. Sindhuri (ch)	4	74	42	3	4	246	5.2	7.2
K. Jyoti (ch)	4	80	37	4	3	302	7.4	10.3
Desiree (ch)	5	71	33	4	4	149	4.1	5.7
Farmers Local (ch)	4	80	40	3	5	185	4.5	6.2
Mean	4	76.4	39.5	3.5	3.4	284	7.6	10.5
F-test	NS	NS	NS	NS	NS	**	**	**
LSD (0.05)	1.0	11.2	11.7	1.0	2.4	131.7	3.1	4.4

NS = not significant at $P<0.05$, ** = Significant at $P<0.01$.

Another set of the participatory varietal evaluation trial was conducted in the Out-reach research sites of RARS Lumle (Table 3.6). Plant uniformity in the tested clones ranged from 2 to 4 in 1 to 5 scales. Local check was better in plant uniformity in some of the tested clones. The percent ground cover was better in Kufri Sindhuri (66%) and in the clone CIP 392617.54. Tallest plants were measured in Janak dev one of the improved check varieties (41 cm) and shortest (12.2 cm) in CIP 388676.1. Second tallest plants were measured in variety Kufri Sindhuri (35.2 cm). Average number of main stems per plant ranged from 2 to 3 only.

Table 3.6: Plant characters and yield of potato genotypes tested at RARS Lumle, 2069/70

Genotypes	Uniformity (1-5)	Ground cover (%)	Plant ht. (cm)	Stem/ plant (no.)	Tuber /plot (no.)	Total wt./plot (kg)	Yield (t/ha)
CIP 388676.1	2	33	12.2	3	142	6.6	18.4
PRP 225861.2	3	54	33.4	2	186	7.6	21.2
CIP380606.6	4	58	27.3	3	230	10.5	29.3
PRP 225861.5	4	63	30.1	3	289	11.2	31.2
CIP 385556.4	4	66	30.4	2	198	8.1	22.6
CIP 392617.54	3	43	31.1	3	140	8.0	22.3
CIP 399244.3	2	49	19.4	2	176	6.3	17.6
Desiree (ch)	2	33	14.2	2	127	6.3	17.8
K. Sindhuri (ch)	4	66	35.2	2	299	10.0	27.9
Janakdev (ch)	4	61	41.9	3	184	8.9	24.8
Mean	2.9	52.5	27.9	2.4	197.4	8.4	23.4
F-Test	*	*	**	NS	*	NS	**
LSD (0.05)	1.6	25.3	15.1	1.1	109.0	3.8	10.6

NS = not significant at $P<0.05$, * = Significant at $P<0.05$, ** = Significant at $P<0.01$.

Total number of tubers was counted highest (418) in the clone L 235-4 and lowest (149) in Desiree. The clone PRP 85861.11 produced highest tuber weight (12.7 kg) per plot and lowest (4.1 kg) by Desiree. The highest yield was obtained from the clone PRP 85861.11 (17.7 t/ha) followed by CIP 392271.58 (13.9 t/ha) and L 235-4 (13.2 t/ha), respectively. The results were highly significant in the parameters like tuber number and weight per plot and tuber yield tons per hectare.

One set of trials was planted at Patmara village, Jumla (Table 3.7). Desiree, Kufri Jyoti and Jumli local were used as the check. Though the percent emergence of the clones tested was more than 90%, CIP 389746.2 had the highest (100%) emergence in Jumla conditions. Plant uniformity did not differ among the tested varieties. Percent ground cover also ranged from 71 in CIP 389746.2 to 95 in Desiree and Kufri Jyoti. Tallest plants were measured in variety Desiree (82 cm) followed by Kufri Jyoti (81 cm). Average number of stems was counted highest (5) and lowest (2) in CIP 393385.39.

Table 3.7: Plant characters and yield potato genotypes tested at Rini, Patmara, Jumla, 2069/70

Genotypes	Emg (%)	Unif. (1-5)	Ground cover (%)	Plt. ht. (cm)	Stem/ plt (no.)	Marketable tubers/plot		Non-marketable tubers/plot		Total yield (t/ha)
						No.	Wt/ (kg)	No.	Wt, (kg)	
CIP393385.39	92	4	79	65	2	26	1.5	36	0.9	13.2
CIP385499.11	98	4	86	74	4	53	2.3	48	1.0	18.4
CIP389746.2	100	4	71	66	3	32	1.8	14	0.4	13.1
L235-4	92	4	84	74	3	32	1.3	46	0.8	12.1
Desiree (ch)	92	4	95	82	5	23	1.2	19	0.5	9.8
K. Jyoti (ch)	96	5	95	81	4	49	1.7	39	1.0	20.2
Jumli Local (ch)	94	5	80	68	3	32	0.9	78	1.0	10.9
Mean										13.2
F-Test										*
LSD (0.05)										6.43

Clone CIP 389746.2 produced highest number and weight of the marketable tubers in Jumla conditions. Non-marketable tubers were harvested from Jumli Local (78/plot). The clone CIP 389746.2 had lowest number (14) and lowest weight of the non-marketable tubers per plot. Variety Kufri Jyoti gave the highest tuber yield tons per hectare (20.2 t/ha) followed by the clone CIP 385499.1 (18.4 t/ha), respectively. Except the variety Desiree, all the tested clones were found high yielding compared to Jumli local (Table 3.7).

3.1.4 Study on Variety Improvement of Potato for Processing

Potato (*Solanum tuberosum* L.) is grown in all ecological zones of 75 districts ranging from 100 m asl to 4400 m above sea level (Dhital and Khatri, 2004). As compared to many cereal crops, it gives an exceptionally high yield, fits well into multiple cropping systems and provides employment. However, its productivity is still low as compared to other neighbouring countries. Up to now, only 8 varieties have been released for commercial cultivation in different agro-ecological regions mainly on the basis of productivity and resistance to the diseases. The yield and processing characteristics of available potato genotypes are unidentified locally despite the increasing demand of processing varieties in the country.

Processing is an important value addition and has high demand in the markets. It is reported that the market value of processed products is far better than the value of raw products (Abbas, 2011). Among different processed products, potato chips are gaining popularity in Nepal due to the changing of food habits, rapid urbanization, and aptitude of new generations for easy to prepare and ready to serve fast food. This is likely to increase further more in the future. The demand of potato chips in Nepalese markets is fulfilled approximately 48% from Indian products, 32% from CG foods and only 20% from local cottage industries. The high import of chips could be due to the unavailability of suitable chipping genotypes and low grade chips produced by local cottage industries. For the preparation of chips, potato should have round or oval shaped tubers and fleet eyes, high dry-matter and specific gravity and low reducing sugars. In Nepal, limited studies have been conducted on processing of potato in the past. Considering above facts different studies were carried out to evaluate promising genotypes for yield and processing quality, storage and spacing trial for production of processing grade potato.

3.1.4.1 Evaluation of potato cultivars for yield and processing qualities at Khumaltar

This experiment was conducted to evaluate suitable genotypes for processing in to chips. Nine promising line selected from previous research were included in this experiment. The experiment was conducted in Randomized Complete Bloch Design (RCBD) with three replications. The crop was planted at Hattiban Farm (1340 m asl), Lalitpur in the third week of January 2012. Tubers were planted in 10.5 m^2 (3.0 m x 3.5m) plot size at a spacing of 60 x 25. Fertilizers were applied @ 150:100:60 kg NPK kg/ha plus with 20 t/ha FYM. All doses of manure and fertilizers were applied before planting the crops. Irrigation was given at 10, 45, 65 and 85 days after plating and while earthing –up was done at 47 and 67 days after planting. The crop was harvested 122 days after planting. Observations were recorded on tuber

characters, yield and chips quality parameters as dry matter, specific gravity and reducing sugar.

Tuber characteristics

Except PRP 25861.1, all other genotypes tested had white skin colour. Four genotypes had round and 5 genotypes had oval shape tubers. Eye depth was recorded shallow in 7 genotypes and medium in 2 genotypes. The flesh colour showed the great variation among the genotypes. Light yellow flesh colour was noticed in 5 genotypes, yellowish in 2 genotypes and white in 2 genotypes. The surface of skin was observed very smooth in Yagana, rough in K. Chipsona-2 and smooth in other tested genotypes. The colour of skin flesh is controlled by genetic factors. Depth of eye is controlled by particular gene and less affected by environment factors (Abbas et al., 2012). Shallow to medium eye depths are most suitable to reduce losses during trimming and peeling. The detail characteristic of tubers is displayed in Table 4.1.

Table 4.1: Effect of potato genotypes on physical characteristics of tubers tested at Hattiban Farm, Khumaltar, 2069/70

Genotypes	Skin color	Tuber shape	Eye depth*	Flesh color	Skin surface
K. Jyoti	White	Oval	S	White	Smooth
HPS II/67	White	Round	S	L. yellow	Smooth
Khumal Seto-1	White	Round	S	White	Smooth
L-235.4	White	Oval	S	L. yellow	Smooth
BSUPO3	White	Round	S	L. yellow	Smooth
Yagana	White	Oval	S	Yellowish	Very Smooth
PRP 25861.1	Red	Oval	M	L. yellow	Smooth
HPS 7/67	White	Round	M	Yellowish	Smooth
K.Chipsona-2	White	Oval	S	L. yellow	Rough

* S= shallow eye depth and M =medium eye depth

Tuber number distribution

No significant variation was recorded on percentage of < 30 g and 30-60 g tuber numbers distribution among the genotypes. All genotypes produced the highest percentage of small size tuber numbers (< 30 g) than medium (30-60 g) and large size (> 60 g) tubers. However, the production of large size tubers was significantly varied among the genotypes. The genotype Kufri Jyoti produced the higher percentage (2.97%) of large size tubers and it was followed by PRP 25861.1 (2.23%), whereas the lowest percentage (0.97%) of large size (processing grade) tubers was recorded in genotype L-235.4 (Table 4.2). The variation of large size tuber numbers among the genotypes could be due to inheritability of genotypes,

rapid plant emergence, better plant growth, length of stolen and difference in maturity. Plant vigour, uniformity and stem numbers /plant showed the positive correlation with large size tubers while height of plant showed the negative correlation (Table 4.3).

Tuber yield

The yield of different grades tuber size sowed the significant and highly significant differences (Table 4.2). The genotype L235-4 produced the maximum tuber yield (11.48 t /ha) of less than 30 g weight and only differed significantly with other genotypes. The yield of medium size tubers was the maximum (22.52 t/ha) in genotype L235-4 and it was followed by PRP 25861.1 (18.88 t /ha), whereas the minimum yield (11. 96 t /ha) was recorded in Genotype Yagana. The maximum yield (27.61 t ha/) of large size (>60g wt.) tubers was recorded in genotype Kufri Jyoti and it was followed by PRP 25861.1(27.62 t/ha), whereas the lowest yield (11.0 t/ha) was observed in genotype Yagana.

The variation on different grades tuber yield could be due to different in emergence percentage, plant height, ground coverage, uniformity and plant height, which were mainly governed by inheritance characters of genotypes. Variation on production of medium and large siz e tubers among genotypes is reported many previous authors (Chapagain *et. al.*, 2011; Abbas *et al.*, 2012). Negative correlation (r = 0.79*) was observed between ground coverage at 100 DAP and yield of medium and large size tubers, while plant vigour at 75 and 100 DAP had positive correlation with medium (r= 0.32) and large size tubers (r = 0.82*) at 75 DAP (Table 4.3). In respect to total yield genotypes showed the highly significant variation. The highest tuber yield (49.42 t/ ha) was recorded in genotype L235-4 followed by genotype K. Jyoti (49.49 t/ ha). However, higher processing grade tubers were recorded in genotypes Kufri Jyoti, PRP 25861.1 and HPS II/67 than L235-4. The genotype Yagana produced the lowest total tuber yield (30.56 t/ ha).The highest yield in L235-4 was mainly due to the higher number of tuber per plant while it was due to big size tubers in other genotypes. Maximum numbers of tubers up to 42 per plant were recorded in genotype L-235.4. Despite higher total yield, the low yield of large size tubers in L-235.4 could be due to its long stolen (data not recorded) and genotypic characters. Comparatively low yield observed in K. Chipsona-2 could be due to low adaptation of this variety in hills of Nepal.

Table 4.2: Effect of potato genotypes on percentage of tuber number distribution and weight (t/ha) at Hattiban Farm, Khumaltar, 2069/70

Genotypes	Tuber no. distribution (%)			Tuber weight (t /ha)			Total yield (t/ha)
	<30 g	30-60 g	>60g	<30 g	30-60 g	>60 g	
K. Jyoti	54.7	42.4	2.97 *a*	5.76 *b*	16.12 *bc*	27.61 *a*	49.49 *a*
HPS II/67	62.6	35.8	1.57*cd*	7.40 *b*	16.04 *bc*	18.08*bc*	41.52 *bc*
Khumal Seto-1	56.5	41.7	1.73 *bc*	8.20 *b*	17.96 *bc*	15.92*cd*	42.08 *bc*
L-235.4	64.3	34.7	0.97 *d*	11.48 *a*	22.52 *a*	15.52*cd*	49.52 *a*
BSUPO3	57.7	40.8	1.53 *cd*	6.08 *b*	17.64 *bc*	15.00*cd*	38.72 *c*
Yagana	63.8	34.9	1.33 *cd*	7.60 *b*	11.96 *d*	11.00 *d*	30.56 *d*
PRP 25861.1	55.6	42.2	2.23 *b*	7.52 *b*	18.88 *b*	22.44 *b*	46.84 *ab*
HPS 7/67	59.5	39.0	1.57 *cd*	6.28 *b*	15.60 *bc*	16.52 *c*	38.40 *c*
K.Chipsona-2	62.8	35.8	1.50 *cd*	8.20 *b*	14.88 *cd*	15.36*cd*	38.44 *c*
F- Value	NS	NS	***	*	***	***	***
LSD (0.05)	13.62	13.39	0.6251	0.029	3.338	4.482	5.173
CV (%)	13.2	20.0	21.1	3.193	11.4	14.8	7.2

ns= not significant, * and *** = significant at 0.0 5 and <0.001 levels, respectively.
In column figures with same letter(s) do not differ significantly at 0.05 level

Table 4.3:Correlation co-efficient (r values) among yield, yield attributing parameters and processing qualities of potato, 2069/70

	V75	V100	U75	U100	SNO	GC%75	GV100	Ht 75	Ht 100	% N<30	%N30-60
SNO	0.02ns	0.37ns	-0.11ns	0.28ns							
GC%75	0.58ns	0.64ns	0.23ns	0.20ns	0.44ns						
GC%100	0.08ns	-0.07ns	0.31ns	-0.13ns	0.25ns	0.67ns					
Ht75	0.48ns	0.48ns	0.14ns	-0.16ns	0.07ns	0.72*	0.60ns				
Ht100	0.15ns	0.06ns	0.23ns	-0.34ns	0.16ns	0.54ns	0.83**	0.68*			
%N30	-0.84**	-0.47ns	-0.51ns	-0.38ns	0.23ns	-0.35ns	-0.20ns	-0.53ns	0.36ns		
%N30-60	0.82**	0.45ns	0.48ns	0.36ns	-0.27ns	0.30ns	0.16ns	0.53ns	0.32ns	-0.10ns	
%N>60	0.80*	0.46ns	0.53ns	0.44ns	0.05ns	0.56ns	0.39ns	0.38ns	0.49ns	0.82**	0.75*
W30	-0.41ns	-0.19ns	-0.25ns	-0.04ns	-0.02ns	-0.23ns	-0.42ns	-0.30ns	-0.61ns	0.696*	0.67*
W30-60	0.32ns	0.40ns	-0.11ns	0.21ns	-0.25ns	-0.27ns	-0.79*	-0.06ns	-0.59ns	-0.13ns	0.17ns
W.60	0.82**	0.65ns	0.30ns	0.44ns	0.12ns	0.51ns	-0.79*	-0.06ns	-0.59ns	-0.13ns	0.17ns
Yield	0.68*	0.65ns	0.11ns	0.43ns	-0.03ns	0.19ns	-0.44ns	0.10ns	-0.27ns	-0.41ns	0.38ns

	%N>60	W30	W30-60	W.60	Yield	DM	SG
W30	-0.69*						
W30-60	0.17ns	-0.12ns					
W.60	0.90***	-0.47ns	0.22ns				
Yield	0.45ns	0.14ns	0.78*	0.75*			
DM	0.23ns	-0.18ns	0.54ns	0.27ns	0.42ns		
SG	-0.19ns	-0.14ns	0.15ns	-0.31ns	-0.21ns	0.64*	
RS	0.04ns	0.22ns	-0.13ns	-0.10ns	-0.08ns	0.16ns	0.30ns

V= plant vigour, U=plant uniformity, SN=stems no plant^{-1},GC=ground coverage%, Ht=plant height, %N<30,%N 30-60 &% N <60= No. of <30,30-60 &<60g tuber yield t/ha, W 30, W 30-60 and W >60 = Different grade tuber wt of tuber t/ha, yield=tuber yield t /ha, DM=dry matter %, SG=specific gravity and RS= reducing sugar (mg /100 g. fresh weight).

Dry matter percentage

Genotypes varied significantly on dry matter content. The lowest dry matter content (16.87%) was observed in Kufri Chipsona-2, whereas the highest dry matter was noticed in PRP 25861.1 (20.10%) followed by Khumal Seto-1(20.0%). Genotypes BSUPO3, HPS II/67, L235.4 and Kufri Jyoti had statistically same dry matter percentage and had higher than Kufri Chipsona-2 and HPS 7/67 (Fig. 4.1). A positive correlation demonstrated between dry matter content to specific gravity (r=0.64*) and dry matter to reducing sugars(r=0.16ns) (Fig.4.3 and 4.4). The variation of dry matter among the genotypes could be due to the interaction effect of genotypes with environment. The variation of DM among the genotypes of this finding is more or less in agreement with the finding of Patel *et al.* (2007) and many others authours. Manivel *et al.* (2007) stated that potato should content >20% DM for production of chips. The acceptable range of DM for chips has been reported 17.19% to 22.99% in Netherlands (Ludwig, 1985).

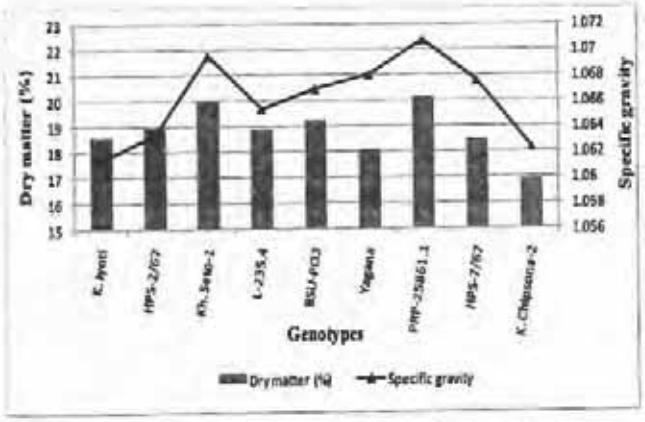


Fig. 4.1. Effect of genotypes on dry matter and gravity of potato grown at Hattiban Farm, Khumaltar, 2012

Specific gravity

Specific gravity showed a significant variation among the genotypes. The genotype PRP 25861.1 (1.070) and Khumal Seto-1 (1.0695) had higher and statistically similar specific gravity, whereas the genotype K. Jyoti had the lowest value (1.061) and it was at par with K. Chipsona-2 (1.062). Positive correlation (r = 0.30ns) was observed between specific gravity and reducing sugars. The specific gravity of potato is directly related to dry matter content of potato. The variation of specific gravity could be probably due to the genetic variability of different potato varieties (Tawfik *et al.*, 2002) and interaction of genotype and environment.

Reducing sugar

There was no significant variation on reducing sugar content on the basis of fresh weight due to the effect of genotypes. All the genotypes exhibited acceptable level of reducing sugars (<150 mg per 100 g. fresh weight) for processing of potato into

chips (Fig. 4.2). It has been reported that the high or low level of reducing sugars has influenced by variety, cultural and environment conditions (Manivel *et al.*, 2007).

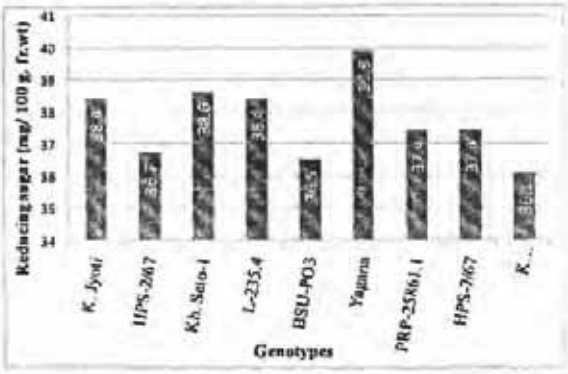


Fig. 4.2. Effect of potato genotypes on reducing sugars content of potato grown at Hattiban Farm, Khumaltar, 2012

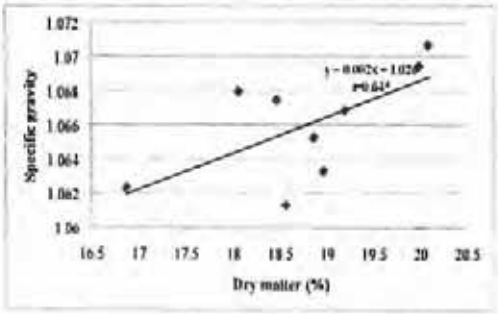


Fig. 4.3 Correlation coefficient between dry matter and specific gravity of potato grown at Hattiban Farm, Khumaltar, 2012

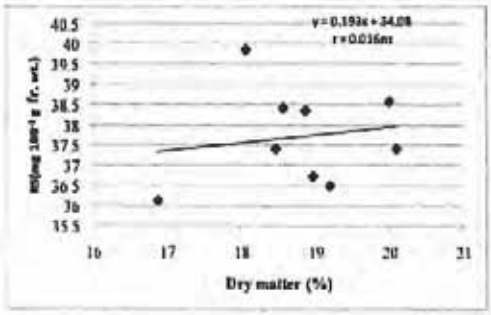


Fig. 4.4 Correlation coefficient between dry matter and reducing sugars of potato grown at Hattiban Farm, Khumaltar, 2012

From the above results and discussion, it is concluded that the genotypes PRP 25851.1, Khumal Seto-1and L235-4 were found most promising for processing due to higher yield, high dry matter, specific gravity content and low level of reducing sugars along with good shape and size of tubers.

3.1.4.2 Evaluation of storability of potato in ordinary condition and cold store

Storage of potato plays an important role to minimize the price fluctuation and continue supply in the market. Storage at high temperature and relative humidity causes heavy losses both in quantity and quality. Lack of adequate storage facilities during production period (April –June) farmers are forced to sale their product at minimum price, whereas the market price increases rapidly and reaches maximum

during October-November (NPDP, 2010). Potato can be successfully stored in cold storage. At present condition, there are very few cold storages in the country which are being utilized for storing of potatoes. Furthermore, cold stored potatoes become sweet due to accumulation of higher levels of reducing sugars and turn dark brown while frying at high temperature due to Millard's reaction (Ezekiel *et al.*, 2007). In the hills and mountains, potato can also be stored successfully for short period at ambient temperature with minimum cost. On-farm storage structures like; heap and pit storage have been developed and utilized for storing potatoes in other countries. However, very few studies in post harvest aspect of potato have been conducted in Nepal. Therefore, to find out the effect of genotypes on storability experiments were conducted at ambient temperature and refrigerated conditions. Ambient temperature storage was conducted at storage house of NPRR and refrigerated storage was conducted in cold store house at Balaju

These experiments were laid out in Complete Randomized Design (CRD) with 3 replications. After harvesting and 15 days curing, apparently healthy tubers with > 60 g weight were selected to study the storability in both conditions. Five kg tubers of nine genotypes were kept in the plastic trays and placed at ambient room temperatures (26.1 ±1.0° C and 62-84% RH) for 120 days. In cold store, tubers were first kept in nylon net bags and then jute bags and kept under store house (2-4°C and 90-92% RH) for 120 days. Observations were recorded in weight loss percentage, sprouting percentage at different days of storage (DOS), number and weight of sprouts, dry matter, specific gravity and reducing sugar after at 120 DOS.

Weight loss percentage

Genotypes varied significantly on total weight loss (TWL) percentage after 30 DOS of storage at ambient temperature (Table 4.4). Up to 30 days of storage, there was non- significant variation on weight loss percentage among the genotypes. The genotype Yagana had the minimum weight loss percentage (12.33%) followed by at L-235.4 (14.70%) up to 120 days storage. The highest weight loss percentage (24.35 %) was observed in genotype BSUPO3 followed by HPS II/67 (22.89%) and K. Chipsona-2 (22.16%). The detail weight loss in different DOS is presented in Table 4.4. The higher weight loss percentage in genotypes BSUPO3, HPS-11/67 and K. Chipsona-2 was due to higher rotting percentage and PRP 25861.1 was due to higher sprouting numbers and weight. The variation in weight loss percentage in different DOS under ambient storage could be due to variation in maturity period, rate of wound healing, thickness of periderm and sprouting characteristics of the genotypes.

Sprouting percentage

The genotypes showed significant variation on sprouting percentage at different days of storage. At 30 days of storage, only two genotypes viz PRP 25861.1 (21.6) and HPS 7/67 (21.3%) showed sprouting and differed with other genotypes. At 60 DOS, these genotypes had more than 75% sprouting, whereas, K. Jyoti had only 9.8% sprouting. At 90 days except K. Jyoti all genotypes showed more than 70% sprouting. At the end of storage (120 days), only K. Jyoti significantly differed with other genotypes for sprouting and had 82.2% sprouting against 100% sprouting in other genotypes. The lower sprouting percentage up to 90 DOS in K. Jyoti and L-235.4 could be due to their genotypic characters associated with its skin thickness. The variation in sprouting percentage among genotypes of this study is in agreement with the findings of previous workers (Rashid *et al.*, 2009; Abbas, 2011).

The genotypes also showed the significant difference on sprout number and weight at 120 DOS (Table 4.5). The maximum number of spouts per tuber (4.47) was recorded in genotype PRP 25861.1, whereas it was the minimum (1.77) in genotype K. Jyoti and it was statistically at par with Yagana (1.83). Similarly the weight of sprouts was observed the minimum (11.52 and 11.53 g /kg tubers) in genotypes K. Jyoti and Yagana respectively whereas it was the highest (32.95 g /kg tubers) in PRP 25861.1. Positive correlation (r=0.81**, 0.60^{ns} and 0.31ns) was observed on sprouting numbers per tuber with sprouting weight at 60, 90 and 120 DOS, respectively and sprouting numbers with sprouting weight (r=0.89**) at 120 DOS (Table 4.7).

Dry matter percentage

The dry matter content increased significantly among the genotypes after 120 days ambient storage. The increased dry matter percentage after storage ranged from 1.69% in K. Chipsona-2 to 5.85% in Khumal Seto-1. Other genotypes lie within these two values (Table 4.6). The increment of dry matter after 120 days ambient storage could be due to their genetic makeup and interaction of genotypes with growing environments due to loss of water from the tubers through respiration and evaporation. The increased in dry matter after storage in heap and pits at 25-35°C for 135 days was also reported by Ezekiel *et al.* (2004). The difference in increasing dry matter among cultivars could be. Dry matter showed the significantly positive correlation with specific gravity (r=0.89*) and no- significant positive correlation with reducing sugar (r=0.024ns) after storage (Table 4.7).

Specific gravity

The increased percentage of specific gravity also showed the significant variation among the genotypes after 120 DOS storage at ambient temperature. It ranged from

the minimum 0.23 in Khumal Seto-1 to the maximum 0.78 in HPS-II/67. The specific gravity had positive correlation with dry matter (r=0.85***) and negative correlation with reducing sugar (r=-0.51^{ns}). The increased in specific gravity after ambient temperature could be due to loss of water, while variation in among genotypes could be due to difference in starch physio-chemical and functional characteristics of genotype. This finding is in the line of agreement of Pinhero *et al.* (2009). They reported that slight increased in starch amylase content during storage, which may affect the specific gravity.

Reducing sugar

Like in dry matter and specific gravity the increased in reducing sugar after 120 days storage at ambient temperature showed significant difference among the genotypes.

Table 4.4: Effect of potato genotypes on total weight loss % at different days of storage under ambient temperature at Khumaltar, 2069/70

Genotypes	Total weight loss % at different days of storage			
	30 DOS	60 DOS	90 DOS	120 DOS
K. Chipsona-2	4.57	10.68 *ab*	15.24 *ab*	22.16 *ab*
HPS -7/67	4.29	6.64 *c*	12.41 *bc*	19.02 *abc*
PRP 25861.1	3.14	6.10 *c*	11.26 *bc*	21.14 *ab*
Yagana	3.26	5.03 *c*	7.50 *c*	12.33 *c*
BSUPO3	3.69	12.80 *a*	19.0 *a*	24.35 *a*
L-235.4	3.13	4.92 *c*	8.29 *c*	14.70 *bc*
Khumal Seto-1	2.91	6.39 *c*	12.16 *bc*	16.46 *abc*
HPS II/67	5.08	8.72 *bc*	16.47 *ab*	22.89 *ab*
K. Jyoti	4.97	7.86 *bc*	12.14 *bc*	16.07 *abc*
F-test	ns	***	**	*
LSD (0.05)	-	3.574	5.945	33.8
CV (%)	45.5	40.0	40.2	40.27

ns= not significant. * and *** = significant at 0.0 5 and <0.001 levels, respectively.
In column figures with same letter(s) do not differ significantly at 0.05 level

After storage the increased in reducing sugar ranged from the minimum 19.6% in K. Jyoti to the maximum 93.3% in Yagana. Other genotypes had increased reducing sugar percentage between these two limits. The detail increasing reducing sugar after storage is depicted in Table 4.7.

However, increased reducing sugar in all genotypes was far below the acceptable limit for processing in to chips, French fries and other dehydrated products. The acceptable limit was 150-250 mg reducing sugar /100g fresh weight (Ezekiel *et al.*, 2003).The increasing of sugars after ambient storage is also reported by Singh and Kaur (2009).

Table 4.5: Effect of potato genotypes on sprouting at different days and number and weight of spouts at 120 DOS under ambient temperature at Khumaltar, 2069/70

Genotypes	Sprouting % at different days of storage				No. of sprouts/ tuber	Weight of sprouts (g/ kg tuber)
	30 DOS	60 DOS	90 DOS	120 DOS	120 DOS	120 DOS
K. Chipsona-2	0.0 *b*	24.9 *bc*	79.8 *abc*	100.0 *a*	2.07 *bc*	15.55 *cd*
HPS -7/67	21.6 *a*	76.2 *a*	94.4 *ab*	100.0 *a*	2.38 *bc*	25.47 *b*
PRP 25861.1	23.13*a*	92.4 *a*	100.0 *a*	100.0 *a*	4.47 *a*	32.95 *a*
Yagana	0.0 *b*	36.2 *bc*	79.8 *abc*	100.0 *a*	1.83 *c*	11.53 *d*
BSUPO3	0.0 *b*	19.4 *bc*	73.5 *bc*	100.0 *a*	2.18 *bc*	19.27 *bc*
L-235.4	0.0 *b*	31.6 *bc*	72.1 *c*	100.0 *a*	2.40 *bc*	16.23 *cd*
Khumal Seto-1	0.0 *b*	39.2 *bc*	91.6 *abc*	100.0 *a*	2.17 *bc*	16.52 *cd*
HPS II/67	0.0 *b*	49.1 *bc*	87.4 *abc*	100.0 *a*	2.63 *b*	21.35 *bc*
K. Jyoti	0.0 *b*	9.8 *c*	43.4 *d*	82.2 *b*	1.77 *c*	11.52 *d*
F-test	***	***	***	***	***	***
LSD (0.05)	3.259	26.58	18.57	6.083	0.6147	6.083
CV (%)	56.3	54.3	19.9	5.3	21.7	27.6

Table 4.6: Effect of potato genotypes on increased percentage of dry matter, specific gravity and reducing sugars after 120 DOS under ambient temperature at Khumaltar, 2069/70

Genotypes	Increased percentage of DM after 120 DOS	Increased percentage of SG after 120 DOS	Increased percentage of RS after 120 DOS
K. Chipsona-2	1.69 *f*	0.30 *d*	47.7 *d*
HPS -7/67	3.60 *bd*	0.49 *abcd*	46.8 *d*
PRP 25861.1	2.55 *e*	0.63 *abc*	61.7 *b*
Yagana	4.24 *bc*	0.47 *bcd*	93.3 *a*
BSUPO3	4.36 *b*	0.39 *cd*	62.1 *b*
L-235.4	3.50 *cd*	0.62 *abc*	55.5 *c*
Khumal Seto-1	5.85 *a*	0.23 *d*	55.3 *c*
HPS II/67	3.21 *de*	0.78 *a*	34.1 *e*
K. Jyoti	5.16 *a*	0.76 *ab*	19.6 *f*
T-test	***	***	***
LSD (0.05)	0.729	0.27520	4.534
CV (%)	49.47	51.40	136.72

*** significant different at < 0.001 level

In column figures with same small letter (s) do not differ significantly by DMRT at 0.05 level

Table 4.7: Correlation coefficient of sprouting percentage, number of sprouts, specific gravity, dry matter and reducing sugar at different days of storage under ambient temperature at Khumaltar, 2069/70

	Spr%60	Spr%90	Spr %120	Spr No.	DM	SG
Sprout no./tuber	0.81**	0.60**	0.31ns			
Sprout wt.(g/kg tuber)		0.89**				
Specific gravity	0.85**					
Reducing sugar					0.24ns	-0.051ns

Spr =sprouting percentage, Sp No. = Sprouting numbers /tuber, DM = Dry matter and SG= specific gravity

3.1.4.3 Evaluation of potato genotypes for storability at cold storage conditions

Weight loss percentage

The pooled analysis of two years data showed significant difference on weight loss percentage among the genotypes after 120 days cold storage both (Table 4.8). The weight loss percentage ranged from minimum 3.53% in Khumal Seto-1 to the maximum 6.83% in Kufri Jyoti after 120 days cold storage while other genotypes lie between these two values. The weight loss after cold storage and 15 days reconditioning at ambient temperature ranged from the minimum Khumal Seto-1 (5.25%) to the maximum Kufri Jyoti (8.86%). Rotting was not observed in all genotypes at 120 days of storage and 15 days after reconditioning.

Dry matter percentage

Except BSU PO3 and Khumal Seto-1 other genotypes showed slight decreased of dry matter after 120 days cold storage. The mean value of all genotypes showed decreased of 1.46% dry matter before storage to after cold storage and 15 days reconditioning. However, the decreasing percentage varied among the genotypes (Table 4.9). The decreased in dry matter after storage is in agreement with the finding of Ezekiel *et al.* (2007). They reported the decreased in dry matter after 55 days storage at12°C at Jalandhar.

Specific gravity

The specific gravity recorded during 2012 also showed not much variation among the genotypes after cold storage. After 15 days reconditioning at ambient temperature, there was slight increased in specific gravity in genotypes Yagana, BSUPO3, L-235.4, Khumal Seto-1 and HPS II/67 while slight decreased in HPS 7/67 (Table 4.9)

Reducing sugar

The reducing sugar content of potato increased rapidly at 120 days after cold storage. The mean increased of reducing sugar was 771.6 percentages after 120 days storage in cold house. However, the increased percentage varied in genotypes (Table 4.10). After 15 days reconditioned all genotypes showed acceptable range of reducing sugar for processing in to chips though there was mean increased of 237.4 percent before storage. The reduction of reducing sugar after reconditioning is in agreement with the finding of Sing *et al.* (2008). At low temperature, potato starch was first converted to sucrose primarily through the action of starch phosphorylase then sucrose is hydrolyzed specially by the action of acid invertase enzyme and eventually increased the reducing sugar (Stiff and Sonnewald, 1995). The variation of reducing sugar after cold storage and recondition among the genotypes could be due to differences in heredity, maturity, age of tubers and difference in membrane permeability of tubers. Singh *et al.* (2008) also reported similar findings. The decreased of reducing sugar after reconditioning in ambient temperature could be due to mainly inactivation of phosphorylase and invertase at higher temperature and increasing the activities of invertase inhibitors. Inactivation of these enzymes at high temperature was reported by earlier authours (Duplessis *et al.*, 1996; Sowokinos, 2001).

Table 4.8: Effect of potato genotypes on weight loss percentage at 120 days cold store and 15 days after recondition, 2069/70

Genotypes	Wt loss % at 120 days cold storage	Wt. loss % at 120 days cold storage and15 days after reconditioned	Increased wt. loss % in 15 days after reconditioned
K. Chipsona-2	6.06 *ab*	8.17 *ab*	34.8
HPS -7/67	5.14 *bcd*	7.15 *bcd*	39.1
PRP 25861.1	5.45 *abc*	7.51 *abc*	37.8
Yagana	3.95 *de*	5.66 *de*	43.3
BSUPO3	5.81 *ab*	7.49 *abc*	28.9
L-235.4	4.74*bcde*	6.53 *cde*	37.8
Khumal Seto-1	3.53 *e*	5.25 *e*	48.7
HPS II/67	4.19 *cde*	6.28 *cde*	49.9
K. Jyoti	6.83*a*	8.86 *a*	29.7
F-test	***	***	
LSD (0.05)	1.309	1.399	
CV (%)	22.2	17.2	

*,** and *** significant at 0.05, 0.01 and <0.001 levels respectively

In column figures with same small letter (s) do not differ significantly by DMRT at 0.05 level

Table 4.9: Effect of potato genotypes on dry matter and specific gravity after cold storage and 15 days reconditioning, 2069/70

Genotypes	Dry matter %			Specific gravity		
	Before storage	120 days cold storage	15 days after recondition	Before storage	120 days cold storage	15 days after recondition
K.Chipsona-2	19.5	16.4	16.8	1.062	1.061	1.062
HPS 7/67	20.0	18.4	18.6	1.074	1.066	1.069
PRP 25861.1	20.3	19.0	17.9	1.072	1.070	1.072
Yagana	18.7	18.3	17.9	1.067	1.071	1.073
BSUPO3	18.0	19.0	18.3	1.071	1.070	1.075
L-235.4	20.3	18.8	17.1	1.064	1.074	1.078
K.Setol	19.2	20.3	18.9	1.067	1.062	1.070
HPS II/67	18.9	18.8	17.2	1.065	1.069	1.069
K. Jyoti	18.5	17.7	17.6	1.061	1.065	1.067
Mean	19.27	18.52	17.81	1.067	1.068	1.071

Table 4.10: Effect of potato genotypes on reducing sugar at 120 days cold storage and 15 days after recondition 2069/70

Genotypes	Before Storage	120DOS	120 DOS and15 days after recondition
K.Chipsona-2	35.5	274.3	52.6
HPS 7/67	39.0	268.7	76.4
PRP 25861.1	36.2	331.1	105.7
Yagana	38.4	277.5	44.6
BSO-PO3	35.3	276.6	111.9
L-235.4	36.6	302.9	99.6
K.Setol	36.3	294.4	121.6
HPS II/67	37.6	229.7	80.5
K. Jyoti	36.3	300.2	93.3
Mean increased (%) of RS		771.6	237.4

3.1.4.4 Effect of chemical treatment on storability and post storage behaviors of potatoes in ordinary Storage

To study the effect of post harvest chemicals and there time of application on storability and chips quality of potato , different chemicals as CIPC, hydrogen peroxide and calcium chloride were tested on potato variety Kufri Jyoti in the mid hill, Khumaltar (1350 m asl) and high hills, Daman (2200 m asl) during the summer season 2012. These chemicals treatments were applied as a single dose (before

storage) and double dose (before and at 45 days in storage). Ordinary water treated potatoes served as control. Experiments were laid out in Completely Randomized Design (CRD) with three replications. The detail of treatments is presented as follows:

Treatments details:

1. Fumigation with CIPC (Isopropyl N-(3-Chlorophenyl) Carbamate) @ 40 ml ton^{-1} potato before storage.
2. Fumigation with CIPC @ 40 ml ton^{-1} potato before storage and 45 days in storage.
3. Fumigation with hydrogen peroxide @ 40 ml ton^{-1} potato before storage.
4. Fumigation with hydrogen peroxide @ 40 ml ton^{-1} potato before storage and 45 days after storage.
5. Fumigation with calcium chloride @ 40 ml ton^{-1} potato before storage.
6. Fumigation with calcium chloride @ 40 ml ton^{-1} potato before storage and 45 days after storage.
7. Control (Fumigation with fresh water @ 40 ml ton^{-1} potato before storage

Forty milliliter of each chemical was first mixed with one liter of methanol and fumigated at the rate of per ton potato. Five kilogram potato (>60 g) of each treatment were fumigated inside close plastic chamber by the given chemicals with the help of small hand operated fumigators and hold air-tied for 48 hours. After 48 hours treated tubers were placed in bamboo racks at Khumaltar and wooden trays at Daman up to 120 days. Observations were recorded on temperature, relative humidity, weight loss percentage (WLP), sprouting weight and sprouting percentage at different days after storage. Similarly, observations were made on dry matter, specific gravity and reducing sugars and fresh chips qualities.

Temperature and relative humidity were recorded at half an hour's interval by using temperature data logger (Hobo). Cumulative weight loss percentage was calculated at every 30 days intervals. For determination of chips qualities, randomly selected 10 potato tubers were peeled and cut into slices of 1.4 mm thickness with a hand operated slicer. Good and undamaged slices were washed thoroughly in cold water to remove the surface starch and sugars. These slices were spread in paper towel to remove surface water and then fried immediately in palm oil at 180° C till stopping of the bubbles. Chips qualities were evaluated on the basis of hedonic rating by group of scientists for color, taste and overall acceptability using 1- 9 scale and crispness; 1-3 scale (higher the number better the color, taste and acceptability).

Storage environment

The maximum temperature ranged from 25 to 3° C, with mean (27° C) and the minimum temperature ranged from 24 to 30° C with mean 26°C at Khumaltar and the maximum temperature ranged from 11 to 24° C, with mean (19° C) and the minimum temperature ranged from 6 to 19° C with mean 14° C at Daman . The relative humidity ranged from 65-98% with mean 82% at Khumaltar and 61-90% with mean 79% at Daman. The detail is presented in Figure 4.5 and 4.6.

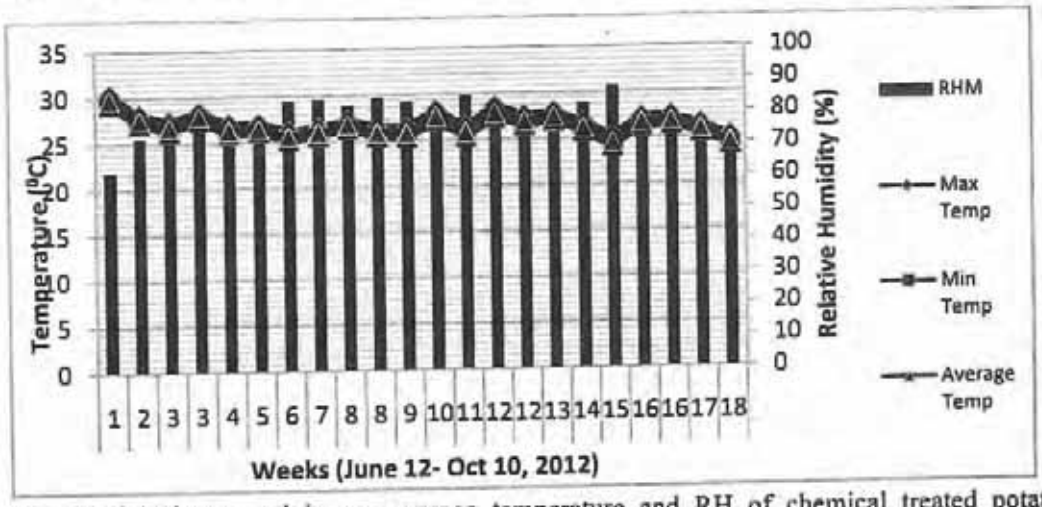


Fig. 4.5 Maximum, minimum, average temperature and RH of chemical treated potato storage room at Khumaltar, 2012

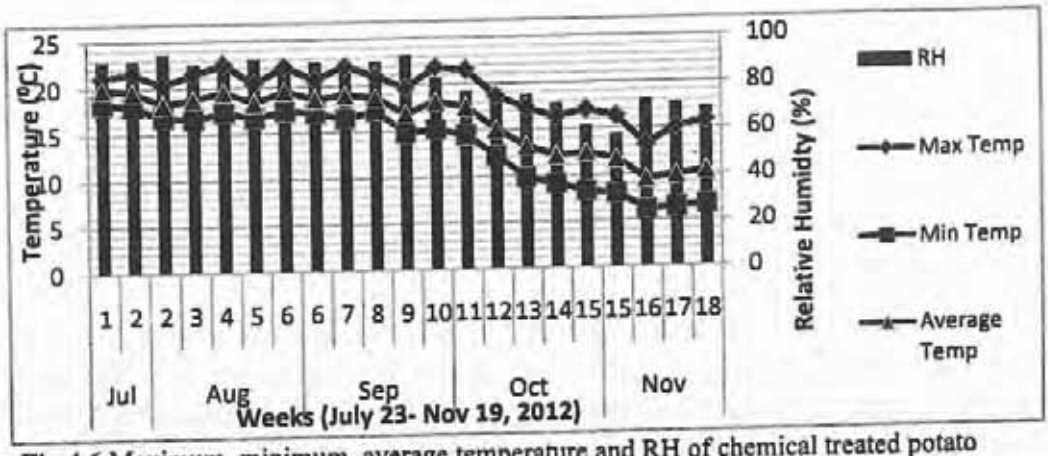


Fig 4.6 Maximum, minimum, average temperature and RH of chemical treated potato storage room at Daman, 2012

Weight loss percentage

There was no significant variation on the weight loss among different treatment up to 30 days of storage.

Table 4.11: Effect of post harvest chemicals treatment on weight loss percentage of potato on different days after storage at Khumaltar and Daman, 2069/70

Treatments	Khumaltar				Daman			
	30	60	90	120	30	60	90	120
CIPC 1x	2.55	7.81 *b*	14.12 *ab*	20.15 *ab*	1.68	2.98	4.34 *bc*	5.62 *cd*
CIPC 2x	2.51	5.16 *b*	7.88 *b*	10.94 *cd*	1.43	2.67	3.45 *c*	4.49 *d*
H_2O_2 1x	2.47	4.43 *b*	7.83 *b*	9.40 *d*	1.86	2.95	4.50 *bc*	6.33 *bc*
H_2O_2 2x	2.99	5.41 *b*	8.35 *b*	13.59*bcd*	2.02	3.62	4.41 *bc*	7.24 *abc*
$CaCl_2$ 1x	1.66	7.33 *b*	11.21*ab*	17.40 *abc*	1.60	2.68	3.77 *c*	7.12 *abc*
$CaCl_2$ 2x	3.77	7.84 *b*	8.50 *b*	14.43*bcd*	1.61	3.62	5.36 *ab*	8.01 *ab*
Control	2.97	13.2 *a*	16.56 *a*	22.89 *a*	2.0	3.79	5.98 *a*	8.77 *a*
F-test	NS	*	*	**	NS	NS	**	**
LSD	-	4.557	6.094	6.598	-	-	1.248	1.667
CV (%)	33.7	35.6	32.7	24.2	24.28	24.1	15.7	14.0

NS = Non significant different, * and ** significant at 0.05 and highly significant at 0.01 levels, respectively. ˜ Same small letters are not significantly different by DMRT at 0.05 levels

At 60 DOS, control treatment had the highest weight loss percentage (13.22 %) at Khumaltar while variation was not recorded on at Daman (Table 4.11). At 90 DOS, treatments differed significantly on weight loss percentage at both locations. The maximum weight loss percentage of 16.56% and 5.98% was recorded on control treatment at Khumaltar and Daman, respectively. After 120 days of storage, weight loss percentage significantly differed among the treatments in both locations. At Khumaltar, the maximum WLP (22.89%) was on control treatment and it was at par with one time fumigation with CIPC (20.15%) and the minimum (9.40%) on one time fumigation with hydrogen peroxide (H_2O_2) treatment, which was at par with two times fumigation with CIPC (10.94%). At Daman, the maximum WLP (8.77%) was also observed on control treatment and it was at par with two times fumigation with H_2O_2 (8.01%) and the minimum (4.49%) on one and two times fumigation with CIPC (5.62%).

Sprouting percentage

The sprouting was noticed after 60 days of storage at Khumaltar and Daman. Treatments differed significantly on sprouting percentage at 60, 90 and 120 days after storage in both locations.

Table 4.12: Effect of post harvest chemical treatments and ambient storage on sprouting percentage at 60, 90 and 120 days at Khumaltar and Daman, 2069/70

Treatments	Sprouting (%) at Khumaltar			Sprouting (%) at Daman		
	60 DOS	90 DOS	120 DOS	60 DOS	90 DOS	120 DOS
CIPC 1x	8.3 *d*	47.60 *b*	82.1 *c*	0.00 *c*	68.3 *b*	83.9 *a*
CIPC 2x	0.0 *d*	0.00*c*	19.8 *d*	0.00 *c*	0.0 *c*	0.00 *b*
H_2O_2 1x	28.0 *c*	74.10 *ab*	85.6 *bc*	0.00 *c*	85.3 *a*	99.5 *a*
H_2O_2 2x	33.0 *c*	84.60 *a*	96.1 *a*	39.3 *b*	92.3 *a*	100 *a*
$CaCl_2$ 1x	59.0 *ab*	80.50 *a*	94.1 *ab*	46.9 *ab*	84.6 *a*	100 *a*
$CaCl_2$ 2x	40.3 *bc*	68.30 *ab*	95.8 *a*	55.6 *a*	93.7 *a*	99.4 *a*
Control	63.1 *a*	82.30 *a*	98.3 *a*	52.4 *a*	95.4 *a*	100 *a*
F-test	***	***	***	***	***	***
LSD (0.05)	19.25	28.98	9.51	9.07	13.59	16.08
CV (%)	32.2	26.5	6.6	18.7	15.8	11.0

** *significant at <0.010 levels, respectively. * Same small letters within the column are not significantly different by DMRT at 0.05 levels

At 60 days, control treatment had the maximum sprouted (63.1%) at Khumaltar and while it was the highest (55.6%) in two time treatment with $CaCl_2$ and it was at par with control treatment (52.4%). At 90 days the maximum sprouted percentage (84.60%) was observed on two times treated with H_2O_2 at Khumaltar and control treatment (95.4%) in Daman. At 120 days of storage, except two times treated with CIPC all treatments showed more than 80 % sprouting at Khumaltar and Daman. Two time CIPC treatments had no sprouting up to 120 days of storage at Daman and only 19.8% sprouted at 120 DOS at Khumaltar (Table 4.12).

Number and weight of sprouts

The numbers of sprouts showed the non-significant and significant differences at Khumaltar and Daman, respectively. At Daman, sprouting was not observed in two times CIPC treatment while other treatments showed no variation on number of sprouts per tuber (Table 4.13).

Table 4.13: Effect of post harvest chemical treatments and ambient storage on sprout numbers and weight at 120 days of storage at Khumaltar and Daman, 2069/70

Treatments	Khumaltar		Daman	
	No. of sprouts /tuber	Wt of sprouts (g)	No. of sprouts /tuber	Wt of sprout (g)
CIPC 1 time	1.43	8.99 *b*	2.13 *a*	2.71 *cd*
CIPC 2 time	1.17	1.72 *c*	0.0 *b*	0.0 *d*
H_2O_2 1 time	2.47	13.18 *a*	2.03 *a*	4.44 *bc*
H_2O_2 2 time	2.33	12.57 *a*	2.30 *a*	7.49 *ab*
$CaCl_2$ 1 time	2.10	11.46 *a*	2.00 *a*	8.15 *a*
$CaCl_2$ 2 time	2.03	12.12 *a*	1.93 *a*	7.89 *ab*
Control	2.13	10.98 *ab*	2.20 *a*	8.23 *a*
F-test	ns	***	***	***
LSD (0.05)	1.152	2.030	0.5694	3.424
CV (%)	36.8	11.4	18.1	35.1

ns = not significant and*** significant at <0.001 level. In column figures with same small letter (s) do not differ significantly by DMRT at 0.05 levels

Weight of sprout recorded at 120 days of storage in both locations differed significantly among the treatments. The minimum weight of sprouts (1.72 g /kg tuber) and no weight was produced by two times treated with CIPC treatment at Khumaltar and Daman respectively, while the maximum weight (13.18 and 8.23/kg tubers) was recorded in one time treated with H_2O_2 and control treatment respectively at Khumaltar and Daman. The detail effect of treatments is presented in Table 4.13.

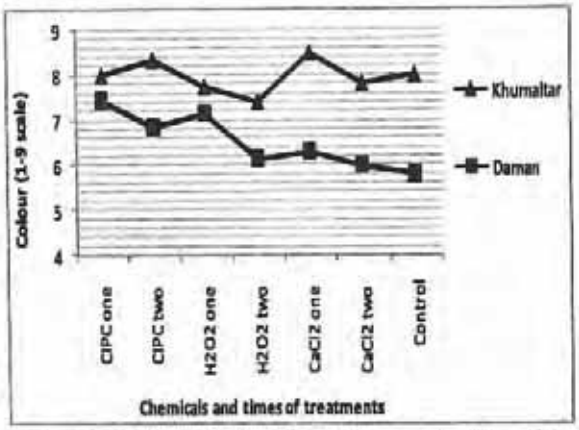


Fig 4.7 Effect of chemical treatments & ambient storage on colour of chips at Khumaltar and Daman during Daman during 2012

The minimum weight of sprouts at Daman was due to low temperature than Khumaltar. CIPC is found most effective to control sprouting in both locations. However, the effect was more at higher altitude. The effect of CIPC for controlling sprouting in heap and pits was also reported by Mehta *et al.*, (2010).

Chips Qualities

Colour of chips

Chips prepared from different chemical fumigated and after 120 days ambient stored tubers showed the no significant and significant differences on colour of chips at Khumaltar and Daman respectively among the treatments. At Khumaltar, all treatment produced acceptable chips colour where as acceptable chips colour (7 or >7 scale) was produced only with one time treatment with CIPC and H2O2 treated tubers.

Taste of chips

Chips prepared from potato tubers after fumigation with chemicals and storage showed no significant variation on taste of chips in mid hill at Khumaltar but showed significant effect in high hill at Daman. At Daman, fumigated of tubers with one and two times with H2O2 produced higher taste score of chips (Fig 4.8).

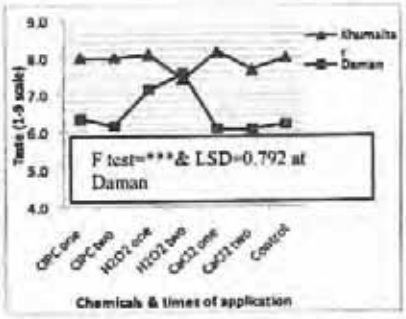


Fig 4.8 Effect of chemical treatments & ambient storage on taste of chips at Khumaltar and Daman during 2012

Crispness of chips

No significant variation was observed among the treatments on crispness of chips in both locations. All treatments had near acceptable score (2 scale) of crispness (Fig 4.9).

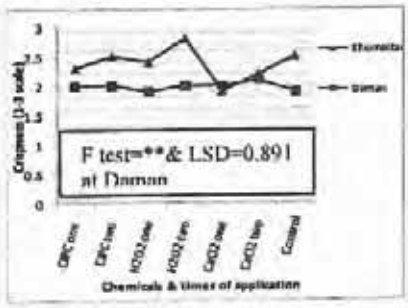


Fig 4.9. Effect of chemical treatments and ambient storage on crispness of chips at Khumaltar and Daman during 2012

Overall acceptability of chips

The chips prepared from potato tubers after fumigation with different chemicals and 120 days storage showed no significant variation on overall acceptability of chips in both locations during 2012. Though there was no significant variation among the treatments on overall acceptability of chips, fumigation one and two times with CIPC produced more scores for overall acceptability at Khumaltar. In high hill Daman, chips prepared from potato tubers

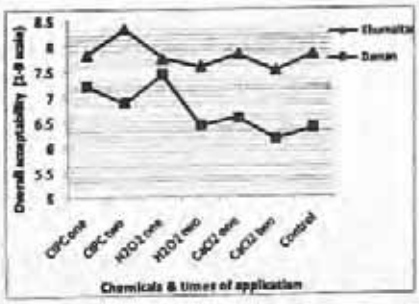


Fig 4.10 Effect of chemical treatments & ambient storage on overall acceptability of chips at Khumaltar and Daman during 2012

fumigated with one time with CIPC and two times with H_2O_2 produced higher acceptable score than other treatments (Fig 4.10).

3.1.3. 5. Spacing trial for processing grade tuber production

Tuber size plays an important role for processing of potato in chips. Larger tuber size (<60g) have minimum losses while peeling and produces uniform slices. The row and plant spacing recommended for potato production for seeds was not found suitable for processing purpose. Most of the farmers used more spacing (90-100 cm row to row) and 30-40 cm plant to plant spacing for production of large size tubers. The recommended spacing by PRP is only suitable for seed size tuber. The review of yield data of past results showed that there was low production of processing grade tubers (<60 g weight). Among the different genotypes, the new genotype L235-4 produced the higher yield and good processing quality. However, it had minimum numbers of processing grade tuber production. Considering this facts experiments were conducted in genotype L235-4 at Hattiban Farm , Khumaltar and farmers field in Chitwan during the summer season of 2012.

The experiment was conducted in RCB design with 4 replications at on-station and 4 farmer's field in Chitwan. A total of 6 treatments consisted three row to row spacing (60, 75 and 90 cm) and three plant to plant spacing (20, 25 and 30 cm) spacing. Fertilizers were applied @ 150: 100:60 kg NPK/ha along with 20 tons FYM/ha before planting the tubers. Observation was recorded on yield and yield attributing parameters and chips grade tuber production.

Vegetative parameters

The data recorded on emergence percentage at Hattiban Farm, Khumaltar showed no significant variation among the different spacing. Similarly, plant uniformity, plant height, numbers of stems/plant showed no significant differences among the different spacing in both locations (Table 4.14 and 4.16). However, ground coverage showed significant differences at Hattiban Farm and no significant differences in famers' field at Saradanagar, Chitwan. At Hattiban Farm, the maximum ground coverage percentage (86.2%) was observed on spacing of 60 x 25 cm whereas, the minimum ground coverage (61.2%) was recorded at a spacing of 90 cm row to row and 30 cm plant to plant spacing.

Yield parameters

The percentage of less than 30 g and 30-60 g tuber numbers showed the no significant and significant differences at Hattiban Farm, Khumaltar and farmers field in Chitwan. The lowest percentage (31.0%) of < 30 g numbers was produced in a spacing of 90x25 cm against the highest percentage (48.0%) at spacing of 60x 25 cm

in Chitwan. The highest percentage (61.0%) of medium grade tubers was produced when the crop was grown at a spacing of 90x 25 cm and the lowest percentage (47.04%) by the spacing of 60 x 25cm (Table 4.17). However, spacing had no effect on production of processing grade (>60 g) tuber numbers.

The weight of <30 g and 30-60 g tubers was significantly affected by different spacing in both locations. The spacing of 60 x 25 cm and 60 x 30 cm produced the higher weight of <30 g tubers in both locations (table 3.15 and 3.17). Medium size tuber weight was recorded highest (19.55 t/ha) at a spacing of 60 x30 cm at Hattiban Farm and 60 x 25cm (10.08 t/ha) and 60 x 30cm (10.04 t/ha) in Chitwan. No significant different was observed on processing grade tubers production due to effect of spacing in both locations.

Table 4.14: Effect of spacing on vegetative growth of potato in genotype L235-4 at Hattiban Farm, Khumaltar, 2069/70

Spacing (RR x PP in cm)	Emergence (%)		Plant vigour (1-5 scale)	Plant uniformity (1-5 scale)	Ground coverage %	Plant height (cm)	No. of stem/plant
	30 DAP	45 DAP					
60x 25	14.6	90.4	4.75	4.63	86.2 *a*	41.6	4.4
60x30	17.7	96.9	4.50	4.50	77.5 *ab*	43.0	4.6
75x25	18.0	93.0	5.0	4.63	78.7 *ab*	45.2	4.6
75x30	10.6	85.0	4.25	4.38	62.5 *b*	42.3	4.0
90x25	13.1	93.1	4.50	4.75	62.5 *b*	44.3	4.4
90x30	14.1	89.9	4.37	4.75	61.2 *b*	41.9	4.8
Mean	14.7	91.4	4.56	4.604	71.5	43.03	4.43
F-test	ns	ns	ns	ns	*	ns	ns
LSD (0.05)	-	-	-	-	18.44	-	-
CV (%)	71.6	13.0	10.9	9.6	17.1	6.8	15.4

ns = not significant and* significant at 0.05 level

In column figures with same small letter (s) do not differ significantly by DMRT at 0.05 level

The spacing had no significant differences on total yield of potato at Hattiban Farm and significant differences in Chitwan. The highest total tuber yield (16.16 t/ha) was observed at a spacing of 60x25cm in Chitwan and it was at par with 60 x25 cm spacing (15.12 t/ha). The lowest tubers yield (8.39 t/ha) was observed at a spacing of 90 x30 cm.

From the above results it can be concluded that the spacing of 60 x25 is best suitable for genotype L235-4. Other necessary measure need to be workout to increase the processing grade tuber production and reduce the stolen length.

Table 4.15: Effect of spacing on different grades tubers production in potato genotype L-235.4 at Hattiban Farm, Khumaltar, 2069/70

Spacing (RR x PP in cm)	Tuber size distribution (%)			Tuber weight distribution (t/ha)			Total yield (t/ha)
	<30 g	30-60 g	>60	<30 g	30-60 g	>60	
60x 25	43.5	49.0	7.25	4.66 *a*	16.53 *abc*	6.56	27.75
60x30	40.7	53.0	6.50	4.61 *a*	19.55 *a*	5.95	30.11
75x25	45.5	48.0	6.0	4.41 *ab*	17.50 *ab*	5.92	27.83
75x30	35.2	54.7	10.0	3.08 *bc*	14.22 *bc*	7.08	24.39
90x25	42.2	49.2	8.50	3.73 *abc*	13.74 *bc*	6.48	23.95
90x30	38.5	52.5	9.50	2.90 *c*	12.41 *c*	6.14	21.45
Mean	41.0	51.1	7.96	3.90	15.66	6.35	25.91
F-test	ns	ns	ns	*	*	ns	ns
LSD (0.05)	-	-	-	1.282	4.312	-	-
CV (%)	13.6	11.0	30.0	21.8	18.3	26.6	16.4

Table 4.16: Effect of spacing on vegetative growth of potato in genotype L-235.4 at farmer's field in Chitwan, 2069/70

Spacing (RR x PP in cm)	Plant uniformity (1-5 scale)	Ground cover (%)	Plant height (cm)	No of stem/ plant
60x 25	3.75	66.2	34.8	2.8
60x30	4.00	75.0	33.9	2.9
75x25	4.00	68.8	38.5	3.3
75x30	4.00	70.0	37.9	2.6
90x25	4.50	70.0	37.8	2.7
90x30	4.00	65.0	38.2	3.0
Mean	4.042		36.83	2.871
F-test	ns	ns	ns	ns
LSD (0.05)	-	-	-	-
CV (%)	11.0	8.7	12.7	12.9

ns = not significant and* significant at 0.05 level

In column figures with same small letter (s) do not differ significantly by DMRT at 0.05 level

Table 4.17: Effect of spacing on different grades tubers production in potato genotype L235-4 at farmer's field in Chitwan, 2069/70

Spacing (RR x PP in cm)	Numbers of tubers distribution (%)			Weight of tubers distribution (t/ha)			Total yield (t/h)
	<30 g	30-60 g	>60 g	<30 g	30-60 g	>60 g	
60x 25	48.0 *a*	47.04 *b*	5.0	3.70 *a*	10.08 *a*	2.39	16.16 *a*
60x30	43.0 *ab*	53.0 *ab*	4.0	2.95 *ab*	10.04 *a*	2.13	15.12 *a*
75x25	42.0 *ab*	54.0 *ab*	4.0	2.00 *bc*	8.40 *ab*	1.29	11.69 *abc*
75x30	37.0 *bc*	56.0 *a*	7.0	2.04 *bc*	8.89 *ab*	2.32	13.24 *ab*
90x25	31.0 *c*	61.0 *a*	8.0	1.06 *c*	6.95 *ab*	2.02	10.02 *bc*
90x30	38.0 *bc*	56.0 *a*	6.0	1.08 *c*	5.60 *b*	1.71	8.39 *c*
Mean	39.8	54.6	5.71	2.14	8.33	1.98	12.44
F-test	**	*	ns	***	*	ns	*
LSD (0.05)	7.43	8.15	-	1.110	3.056	-	4.204
CV (%)	12.4	9.9	42.3	34.5	24.4	39.8	22.4

ns = not significant and*,** ,*** significant at 0.05, 0.01 and <0.001 levels respectively.
In column figures with same small letter (s) do not differ significantly by DMRT at 0.05 level

3.1.4.6 Verification of promising lines for processing potato production in hills and terai conditions

Selected six processing genotypes for chips making were evaluated at on-station and farmers field in Chitwan. Experiments were conducted in RCB design with 3 replications in both locations. One farmer was taken as one replication at Saradanagar in Chitwan. Fertilizers were applied @ 150: 100:60 kg NPK/ha along with 20 tons FYM/ha before planting the tubers. Observation was taken on vegetative, yield parameters and processing parameters.

Vegetative parameters

Emergence percentage at 30 DAP, plant uniformity, ground coverage percentage and plant height at 90 DAP showed the significant difference among the genotypes at Khumaltar. The detail of these parameters is presented in Table 4.18. However, at farmers' field in Chitwan, emergence percentage at 15 DAP and number of stem/plant showed significant variation among the genotypes (Table 4.18).

Table 4.18: Vegetative parameters of promising genotypes of potato at Hattiban Farm, Khumaltar, 2069/70

Genotypes	Emergence percentage		Plant vigour (1-5 scale)	Plant uniformity (1-5 scale)	Ground coverage (%)	Plant height (cm)	No of stem/plant
	30 DAP	45 DAP					
PRP25861.1	44.7 *c*	99.33	5.0	4.67 *ab*	59.5 *a*	66.7 *cd*	5.13
BSUPO3	72.0*ab*	96.0	4.33	4.0 *bc*	43.5 *bc*	58.3 *d*	5.73
L-235.4	36.0*cd*	97.33	4.33	5.0 *a*	48.5 *ab*	85.0 *a*	4.93
CIP389746.2	22.7 *d*	95.33	3.83	4.33 *abc*	43.2 *bc*	61.7 *d*	3.27
HPS 7/67	72.0*ab*	100.0	4.67	3.67 *c*	57.3 *a*	81.7 *a*	5.73
HPS II/67	56.7*bc*	95.33	4.67	3.67 *c*	60.7 *a*	80.0 *ab*	5.40
K. Jyoti	85.33*a*	99.33	4.0	5.00 *a*	34.9 *c*	71.7 *bc*	6.33
Mean	55.6	97.52	4.40	4.33	49.7	72.1	5.22
F-test	***	ns	ns	**	**	***	ns
LSD (0.05)	20.88	-	-	0.7764	11.42	8.97	-
CV (%)	21.1	2.8	13.6	10.1	12.9	7.0	17.9

Yield Parameters

The number of less than 30 and more than 60 g tuber distribution percentage varied significantly among the genotypes at Khumaltar while only more than 60 g tuber distribution was varied significantly in Chitwan. The highest percentage (17.3%) of >60 g tuber numbers was counted in genotype Kufri Jyoti at Khumaltar and 25.0% in genotype CIP 389746.2 in Chitwan. The genotype L-235.4 had the lowest percentage of >60 tubers in both locations (Table 4.19 and 4.20).

The genotypes differed significantly for production of 30-60 g and more than 60 g tuber weight at Khumaltar and more than 60 g weight in Chitwan. The genotype L-235.4 (13.99 t/ha) and Kufri Jyoti (12.77%) had the highest tuber yield of 30-60 g and more than 60 g respectively, at Khumaltar. In Chitwan, the genotype CIP389746.2 produced the highest tuber yield (13.5 t/ha) of more than 60 g tubers (processing grade tubers). However, genotypes did not differ significantly for production of total tuber yield in Chitwan (Table 4.21), whereas in Khumaltar Kufri Jyoti produced the significantly the highest tuber yield of 28.85 t/ha (Table 4.19).

Processing quality

The dry matter and specific gravity was recorded the highest 20.8% and 1.078 in genotype CIP 389746.2 at Khumaltar and 20.3% and 1.079 in HPS 7/67 in Chitwan. The lowest dry matter and specific gravity was recorded in Kufri Jyoti in both locations (Table 4.22).

Table 4.19: Yield parameters of promising genotypes of potato at Hattiban Farm, Khumaltar, 2069/70

Genotypes	Numbers of tubers distribution (%)			Weight of tubers distribution (t/ha)			Total yield (t/ha)
	<30 g	30-60 g	>60 G	<30 g	30-60 g	>60	
PRP 25861.1	33.3 *bc*	58.7	8.0*bc*	1.94	10.12 *abc*	3.90 *b*	15.94 *c*
BSUPO3	49.0 *a*	43.3	7.7 *bc*	3.36	9.27 *c*	4.37 *b*	16.99 *bc*
L-235.4	43.7 *ab*	51.3	4.7 *c*	4.64	14.51 *a*	3.57 *b*	22.76 *b*
CIP 389746.2	42.7 *ab*	44.7	12.7 *ab*	2.12	7.48 *c*	5.80 *b*	15.40 *c*
HPS 7/67	38.7 *abc*	51.3	10.0 *abc*	2.10	9.70 *bc*	5.50 *b*	17.41 *bc*
HPS II/67	39.3 *abc*	50.3	10.3 *abc*	2.40	10.21 *abc*	6.13 *b*	18.73 *bc*
K. Jyoti	28.3 *c*	54.0	17.3 *a*	2.08	13.99 *ab*	12.77*a*	28.85 *a*
Mean	39.2	50.5	10.10	2.68	10.76	6.0	19.44
F-test	*	ns	*	ns	*	**	**
LSD (0.05)	10.68	-	7.016	-	4.255	4.127	5.533
CV (%)	15.3	10.9	39.1	37.3	22.2	38.6	16.0

Table 4.20: Yield and yield parameters of promising genotypes of potato at Farmers field Chitwan, 2069/70

Genotypes	Emergence percentage		No of stem /plant	Tuber size distribution (%)		
	15 DAP	30 DAP		<30 g	30-60 g	>60 g
PRP 25861.1	8.0*bcd*	47.3	3.4 *b*	27.3	57.7	14.3 *b*
BSUPO3	10.33*bc*	48.0	4.4 *a*	20.3	58.7	21.0 *a*
L-235.4	3.0 *d*	39.7	3.1 *b*	22.7	70.3	7.0 *c*
CIP389746.2	14.33*ab*	46.0	3.4 *b*	21.0	54.0	25.0 *a*
HPS 7/67	2.67 *d*	42.0	3.8*ab*	32.3	56.7	11.3*bc*
HPS II/67	4.0 *cd*	37.0	3.6*ab*	41.3	50.0	8.67*bc*
K. Jyoti	18.67 *a*	43.7	3.1 *b*	23.7	53.7	22.33*a*
Mean	8.71	43.4	3.536	27.0	57.3	15.67
F-test	***	ns	*	ns	ns	***
LSD (0.05)	6.428	-	0.7987	-	-	5.784
CV (%)	41.5	10.7	12.7	35.1	14.5	20.8

The content of reducing sugar is below the acceptable limit (<150 mg/ 100 g fresh wt.) in all genotypes at both locations. Though there was no significant variation on tuber yield among the genotypes in Chitwan, farmers preferred the genotype PRP 25861.1 due to its red skin.

Table 4.21: Yield and yield parameters of promising genotypes of potato at Farmers field Chitwan, 2069/70

Genotypes	Weight of tubers distribution (t/ha)			Total yield (t/ha)
	<30g	30-60 g	>60 g	
PRP 25861.1	1.19	11.55	8.06 bcd	20.80
BSUPO3	0.97	12.85	12.44ab	26.25
L-235.4	1.18	14.22	3.72 d	19.12
CIP389746.2	0.74	8.67	13.50 a	22.91
HPS 7/67	1.93	13.92	7.74 cd	23.59
HPS II/67	1.85	12.92	6.0 d	20.78
K. Jyoti	0.97	11.26	11.68abc	23.90
Mean	1.26	12.20	9.02	22.48
F-test	ns	ns	**	ns
LSD (0.05)	-	-	4.318	-
CV (%)	40.2	24.0	26.9	20.3

Table 4.22: Processing quality parameters of promising genotypes of potato at Hattiban Farm, Khumaltar and farmers field Chitwan, 2069/70

Genotypes	Khumaltar			Chitwan		
	DM (%)	Specific gravity	Reducing sugar (mg/100g fr. wt)	DM (%)	Specific gravity	Reducing sugar mg/100g fr. wt)
PRP 25861.1	20.5	1.074	35.8	19.1	1.068	30.0
BSUPO3	18.0	1.068	35.3	18.7	1.075	34.4
L-235.4	20.2	1.072	36.5	16.5	1.072	33.8
CIP389746.2	20.8	1.078	42.5	17.3	1.067	65.7
HPS 7/67	19.8	1.070	39.3	20.3	1.079	69.0
HPS II/67	18.9	1.067	37.4	18.7	1.065	34.8
K. Jyoti	18.3	1.061	36.0	18.3	1.065	31.9

3.1.5 Develop low cost PBS production technologies and maintain quality of different levels of seed standards in three major agro-ecological regions

Since the establishment of tissue culture laboratory and the glasshouse in 1989, National Potato Research Programme (NPRP) has been producing certain amount of PBS annually (NPRP, 2007/8). In spite of budgetary constraint, NARC is expending some budget for the production of valuable planting materials (PBS) each year. However, the program is providing the PBS to the stack-holder / farmers at subsidized price so as to make it affordable to the farmers. To sustain such a high cost pre-basic seed production program, there is no other alternative other than to reduce the cost of production and increase the efficiency of *in vitro* multiplication and subsequent PBS production under glasshouse condition. Selection of appropriate and efficient methods for *in vitro* rapid multiplication of plantlets and microtuber production under *in vitro* conditions and sustainable and, economic production PBS under glasshouse is the main focus the laboratory unit. In case of light supply under incubation room, it needs 16 h light of 2000 Lux per day, but during the dry season there is only 10-12 h power supply. From last fiscal year, new program "Soilless medium (Hydroponic)" has been introducing in the small scale as an experiment for PBS production.

To overcome these problems, program has already done some studies and published results on the use of natural light for *in vitro* plantlets under laboratory conditions. Similarly, proper utilization of PBS is also the most important part in quality seed potato production program and in other hand it is also necessary to explore the important of quality seed (basic seed) through farmer participation. The overall reduction in the cost of *in vitro* plantlets and maximum production of medium to large size PBS under glasshouse are prime importance in reducing cost per unit PBS. To solve the above mentioned various problems; the objectives of these studies were to efficient and rapid multiplication of plantlets under *in vitro* conditions, efficient production of minituber in a sustainable way and to know about the virus status of the succeeding generation of PBS under on-farm as well as on-station.

3.1.5.1 Long term preservation of potato germplasm under *in vitro* conditions

There are several chemicals (plant growth retardants; PGR) for long term conservation of potato germplasm under *in vitro* conditions. These are ABA, maleic hydrazide (MH), chlorichorine chloride (CCC) etc (Lizarraga et al, 1989). The experiment was conducted under *in vitro* condition during 2012/13. Ten single nodes were sub-cultured on each jar and 10 bottles per replication and repeated into three times. Potato cultivars Janak Dev was used in the study. Treatment combination is given in the Table 5.1. After one month of sub-cultured, necessary

parameters were taken in every month. Compared to control or standard checked, all tested plant growth regulators showed good effects on most of the measured parameters. However, maleic hydrazide (8 ppm) showed better effects by making slow growth of the tested plants under *in vitro* condition followed by ABA (5 ppm) (Table 5.1 and 5.2). After three months, the most of the treatments were contaminated, so could not maintained further for continue observation. Anyway, within the short period of experimentation, PGR showed some effects on the growth and development of root and shoot of the sub-cultured plants. This study will be continuing in the next year with some improvement in the laboratory conditions.

Table 5.1: Effect of different chemicals on plant establishment, plant height and node/plant under *in vitro* condition, 2069/70

Treatment	% plant establish	Plant height (cm)			Node/ plant (No.)		
		1st month	2nd month	3rd month	1st month	2nd month	3rd month
ABA @ 2 ppm	85	0	2.6	5.1	0	2.7	5.1
ABA @ 5 ppm	90	0	1.4	4.9	0	1.7	3.5
ABA @ 10 ppm	85	0	Cont.	Cont.	0	Cont.	Cont.
MH @ 5 ppm	90	3.5	Cont.	Cont.	2.1	Cont.	Cont.
MH @ 10 ppm	95	2.0	4.1	6.2	1.2	4.2	4.9
MH @ 20 ppm	90	2.0	3.2	3.8	1.1	4.8	5.1
CCC @ 2 ppm	95	2.6	7.8	8.2	2.3	7.1	8.2
CCC @ 4 ppm	90	2.5	7.5	Cont.	3.1	6.1	Cont.
CCC @ 6 ppm	90	3.1	6.7	8.0	3.0	6.5	7.3
Control (only MS)	90	5.2	9.5	Cont.	4.2	9.8	Cont.

Maleic hydrazide (MH), Chlorichorine chloride (CCC), Cont. = Contaminatio

Table 5.2: Effect of different chemicals on leaf and branch development and on root length under *in vitro* condition, 2069/70

Treatment	Leaf/ plant (No.)			Branch/ plant (No.)			Root length (cm)		
	1st month	2nd month	3rd month	1st month	2nd month	3rd month	1st month	2nd month	3rd month
ABA @ 2 ppm	0	3.5	6.7	0	0	2.1	0	2.5	3.2
ABA @ 5 ppm	0	2.2	6.0	0	0	1.6	0	2.0	3.0
ABA @ 10 ppm	0	Cont.	Cont.	0	0	Cont.	0	Cont.	Cont.
MH @ 5 ppm	5.6	Cont.	Cont.	1.0	2.2	Cont.	1.5	Cont.	Cont.
MH @ 10 ppm	4.6	9.0	11.2	1.0	1.8	2.5	0	3.1	5.0
MH @ 20 ppm	4.8	7.3	8.4	0	1.2	2.6	0	2.8	3.8
CCC @ 2 ppm	7.5	11.0	13.1	1.5	3.2	3.9	2.5	4.8	7.5
CCC @ 4 ppm	6.0	12.5	Cont.	2.0	3.10	Cont.	2.0	5.0	Cont.
CCC @ 6 ppm	5.8	9.5	10.4	1.2	1.7	5.2	1.6	4.1	7.6
Control (only MS)	9.5	12.3	Cont.	2.1	3.1	Cont.	3.1	6.0	Cont.

Maleic hydrazide (MH), Chlorichorine chloride (CCC),
Cont. = Contamination

3.1.5.2 Comparative study of hydroponic and soil based medium for efficient production of PBS under glasshouse conditions

This experiment was designed to know the performance of hydroponic cultivation system in potato for minituber production. Before planting, *in vitro* plantlets were rooted in the sterilized sand medium for 2-3 weeks under glasshouse condition on plastic tray. Five varieties were planted in the bed i.e. Kufri Jyoti, Cardinal, IPY-8, L-235.4, Janak Dev and Khumal Seto-1. One day before planting, nutrient medium was formulated and mixed in the over head tank and circulated in the planting bench and underground tank and again in the overhead tank using electric pump. The plants were planted on 2069/6/22 and harvested on 2070/10/21. From the experiment number of plant established, plant height, number of main stem, tuber/plant and yield of PBS were recorded.

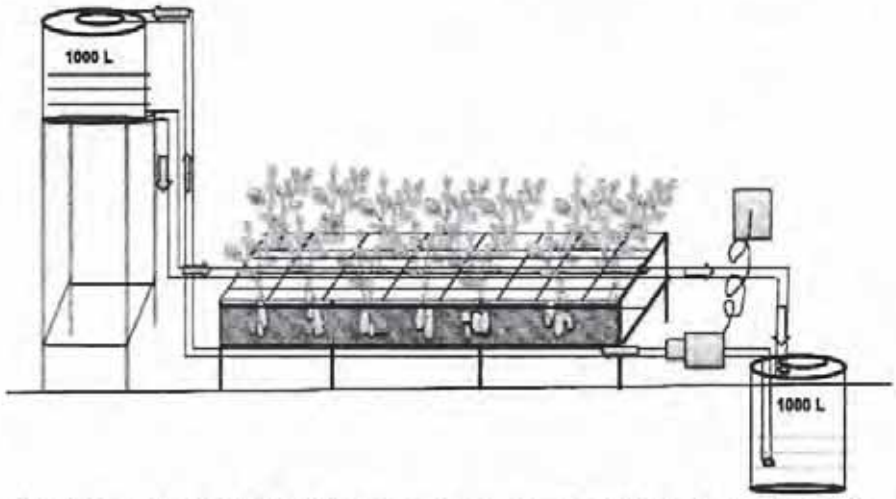


Fig. 5.1 A sample sketch of hydroponic system for PBS production of potato

Necessary facilities were not completely established in the glasshouse; however, planting was done in the basic facility. The plant establishment and plant height was found good, and tuber formation was also satisfactory in hydroponic system compared to the soil based medium (Table 5.3).

Table 5.3: Comparative study of hydroponic and soil based medium for minituber production under glasshouse conditions, 2069/70

Treatment	Plant establish (%)	Plant ht. (cm)	Minituber/plant (No.)	Minituber yield/ plant (g)
Kufri Jyoti				
Soil medium	90.5	54.8	4.7	45.5
Soilless medium	85.5	50.5	11.8	85.1
Cardinal				
Soil medium	95.5	62.0	4.4	50.2
Soilless medium	80.5	58.0	7.3	72.6
Janak dev				
Soil medium	90.0	76.5	7.1	65.3
Soilless medium	82.5	58.5	17.5	105.5
Khumal seto-1				
Soil medium	90.4	65.1	3.1	88.8
Soilless medium	85.2	60.2	23.6	210.4
L235-4				
Soil medium	96.3	56.5	6.8	95.5
Soilless medium	86.2	48.5	14.2	110.5

The maximum tuber number per plant was 81 observed in Janak Dev in hydroponic whereas, the maximum tuber number was 19 in Khumal Seto-1 under soil base medium. Tuber number as well as tuber yield was found satisfactory in hydroponic cultivation (Table 5.3 and Fig. 5.2). Under hydroponic cultivation all the tested potato varieties produced higher number and yield with compared to soil base medium cultivation (Table 5.3).

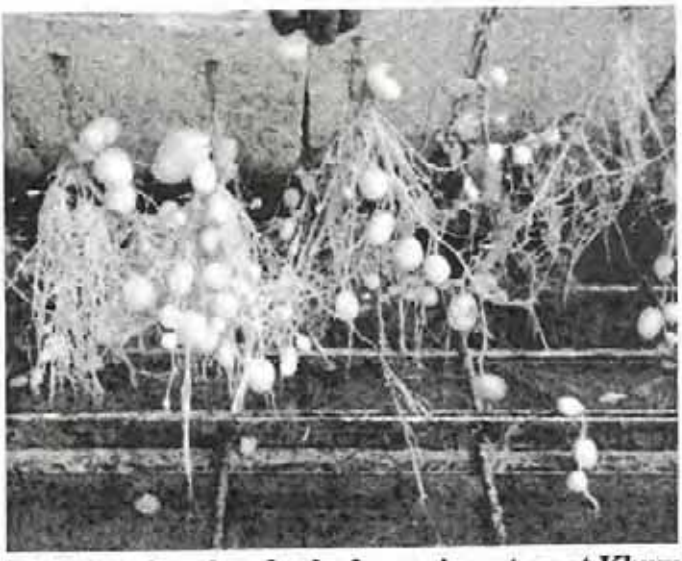


Fig. 5.2 PBS of potato produced under hydroponic system at Khumaltar

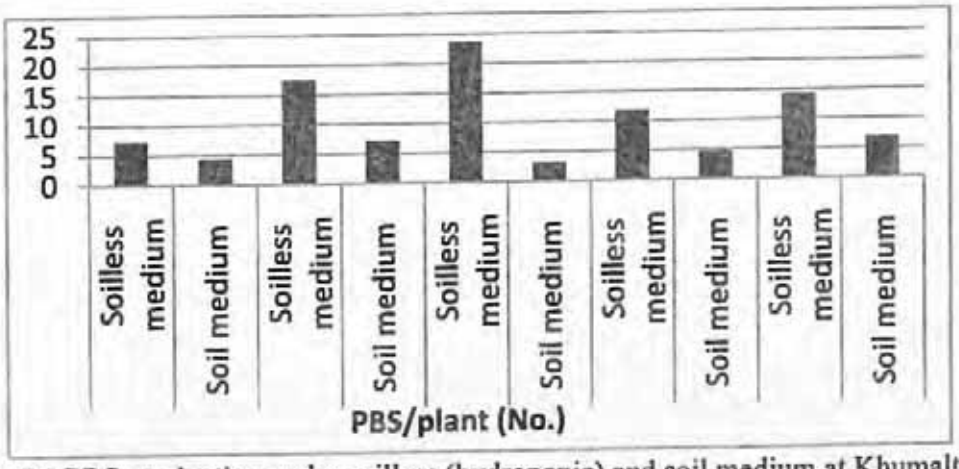


Fig. 5.3 PBS production under soilless (hydroponic) and soil medium at Khumaltar

3.1.5.3 Degeneration studies of PBS under different agro-ecological zones at field conditions

In potato crop, degeneration is mostly due to infection with one or more viruses which reduce potato yield by 10-60 %. When we go in specific viruses the yield reduction is varied with individual virus, yield reduced by 50-95% with PLRV infection, PVX cause 5-70% yield loses PVM yield loss of about 10%, 11-38% by PVS and PVS, up to 60 % by combined effect of PVS and PVA and up to 95 % by PVY. In this way yield reduction by virus infection depends, on percentage of infected plants and the type of virus(es) infecting the plant. Potato seed degeneration study had been conducted for several years by Potato Research Programme (Annual Reports, 1984/85; 1988/89-1992/93). The study was done only by comparing rouged and none rouged of virus infected plants. But, because of the change of seed lots during the study period, the infected plants appeared occasionally and so significant yield differences were recorded between the compared treatments, and hence, yielded no output. During the fiscal year 2069/70 the experiment was conducted at two locations, RARS, Parwanipur, Bara to represent the tropical region and NPRP, Khumaltar, Lalitpur to represent the sub-tropical region of Nepal.

The treatment combination were (1) covered by insect proof net, (2) only spraying of appropriate insecticides when aphid population reaches critical (3) only rouging of infected plant (negative selection) (4) spraying of appropriate insecticides and rouging of infected plant (negative selection) (2+3) and (5) no spray and rouging (control). The plot was manure at the rate 100:100:60 kg/ha NPK and compost at 20 t/ha. Aphid population dynamics study; aphids were observed at weekly interval using leaf count and yellow water tray methods. After harvest, three seed size tubers will be brought back to Khumaltar and stored in PRP's coldstore. At the field condition, visual observation method was applied for virus monitoring. Five tubers from each treatment were collected during harvesting time and that was used for virus testing by DAS-ELISA method at Khumaltar. Potato cvs. Kufri Jyoti and Cardinal were used at Parwanipur and Kufri Jyoti and Janak Dev were used at Khumaltar condition.

At Khumaltar, the PBS was planted on 2069/10/3 and harvested on 2070/1/21 and at RARS, Parwanipur PBS was planted on 2069/6/22 and harvested on 2069/9/28. All cultural operations were done as and when needed at both locations. In both places, none of the potato viruses were observed under field conditions and observed only some insects (aphids and beetle) in some plots. The plant characters and disease reaction under field condition is given in table 5.4 and 5.9, tuber yield and seed size

distribution in table 5.5 and 5.8 and virus status by DAS-ELISA method in table 5.6 and 5.9. Tuber yield and other plant characters were according to their varietal characters. This is the first year of the study so treatment showed no significant difference on virus status at field as well as laboratory test under both conditions. In the case of virus test by DAS-ELISA, none of the tested samples were found infected by the viruses, however, the virus concentration was varies within the sample as well in the types of viruses. Similar trend was observed in both of the locations (Table 5.6 and 5.9).

Table 5.4: Plant characters and disease reaction (under field condition) of potato planted under degeneration studies at NPRP, Khumaltar, 2069/70

Treatments	Emergence count	Uniformity (1-5)	Stem /plant No	Plant height (cm)	PLRV	PVA	PVM	PVS	PVX	PVY	Remarks
V1T1	49.67	4.7	3.7	32.0	-	-	-	-	-	-	-
V1T2	49.00	3.7	3.2	24.8	-	-	-	-	-	-	-
V1T3	49.67	4.3	3.9	27.4	-	-	-	-	-	-	Observed aphid
V1T4	50.00	4.3	3.3	27.8	-	-	-	-	-	-	-
V1T5	49.67	3.7	3.5	31.3	-	-	-	-	-	-	-
V2T1	49.00	3.3	2.7	89.8	-	-	-	-	-	-	-
V2T2	47.67	4.3	2.7	62.2	-	-	-	-	-	-	-
V2T3	48.00	3.7	2.5	62.7	-	-	-	-	-	-	-
V2T4	47.00	3.3	2.5	68.7	-	-	-	-	-	-	-
V2T5	49.00	3.3	2.4	68.2	-	-	-	-	-	-	Observed aphid

Plot size: 7.5 m^2 (3 m x 2.5 m)

V1 = Kufri Jyoti, V2 = Cardinal; T1: Covered by insect proof net, T2: Only spraying of appropriate insecticides when aphid population reaches critical, T3: Only rouging of infected plant (Negative selection), T4: Spraying of appropriate insecticides and rouging of infected plant (Negative selection) (2+3), T5: No spray and rouging (control)

Table 5.5: Yield and tuber size distribution of potato planted under degeneration studies at NPRP, Khumaltar condition, 2069/70

Treats /rep	Plant harvested (No.)	Tuber size distribution (No. wt./plot)						Tuber No./plot	Yield /plot(kg)
		Under size		Seed size		Over size			
		No.	wt. kg	No.	wt. kg	No.	wt. kg		
V1T1	50	53.0	0.43	139.3	5.40	39.3	4.30	231.7	10.20
V1T2	50	65.3	0.43	160.3	6.40	40.0	4.23	265.7	11.00
V1T3	50	53.7	0.37	141.3	5.23	38.3	3.63	233.3	9.23
V1T4	50	65.0	0.57	149.7	5.83	40.7	4.63	255.3	11.03
V1T5	49	73.0	0.60	152.7	5.90	58.0	5.43	283.7	11.93
V2T1	50	66.3	0.47	160.7	6.30	49.3	4.80	276.3	11.53
V2T2	50	49.7	0.30	134.7	5.70	36.7	4.10	221.0	10.13
V2T3	50	34.7	0.20	120.3	4.90	40.3	4.20	195.3	9.27
V2T4	50	48.3	0.40	137.3	5.70	50.0	5.23	235.7	11.33
V2T5	50	27.3	0.20	132.7	6.33	25.7	2.93	185.7	9.47

Table 5.6: Virus status by DAS-ELISA test (under laboratory condition) of the potato planted under degeneration studies at NPRP, Khumaltar condition, 2069/70

Treatment	Potato viruses infection tested by DAS-ELISA					
	PLRV	PVA	PVM	PVS	PVX	PVY
V1T1	0.160	0.071	0.084	0.076	0.074	0.091
V1T2	0.194	0.100	0.121	0.068	0.067	0.105
V1T3	0.188	0.091	0.099	0.076	0.081	0.101
V1T4	0.107	0.086	0.080	0.077	0.065	0.088
V1T5	0.115	0.064	0.074	0.062	0.066	0.086
V2T1	0.131	0.091	0.112	0.088	0.078	0.100
V2T2	0.110	0.071	0.096	0.077	0.063	0.088
V2T3	0.124	0.084	0.089	0.079	0.072	0.096
V2T4	0.133	0.080	0.078	0.061	0.067	0.091
V2T5	0.155	0.086	0.085	0.076	0.072	0.102
Negative control (OD)	0.102	0.064	0.081	0.073	0.067	0.080

Plot size: 7.5 m^2 (3 m x 2.5 m)

V1 = Kufri Jyoti, V2 = Janak Dev; T1: Covered by insect proof net, T2: Only spraying of appropriate insecticides when aphid population reaches critical, T3: Only rouging of infected plant (Negative selection), T4: Spraying of appropriate insecticides and rouging of infected plant (Negative selection) (2+3), T5: No spray and rouging (control)

Table 5.7: Plant characters and disease reaction (under field condition) of potato planted under degeneration studies at RARS, Parwanipur condition, 2069/70

Treatments	Emergence	Uniformity (1-5)	Stem /plant No	Plant height (cm)	PVA	PVM	PVS	PVX	PVY	PLRV	Remarks
V1T1	49.7	4.7	4.2	32.7	-	-	-	-	-	-	
V1T2	49.7	4.0	3.4	24.8	-	-	-	-	-	-	Beetle
V1T3	50.0	4.7	3.9	27.4	-	-	-	-	-	-	
V1T4	50.0	4.3	3.5	27.8	-	-	-	-	-	-	
V1T5	50.0	4.3	4.07	31.3	-	-	-	-	-	-	Observed aphid
V2T1	49.7	4.0	2.7	89.8	-	-	-	-	-	-	
V2T2	48.0	4.3	2.4	62.2	-	-	-	-	-	-	
V2T3	48.7	4.3	2.53	62.7	-	-	-	-	-	-	Beetle
V2T4	48.0	4.0	2.57	68.7	-	-	-	-	-	-	Observed aphid
V2T5	49.3	4.0	3.13	68.2	-	-	-	-	-	-	

Table 5.8: Yield and size distribution of potato planted under degeneration studies at RARS, Parwanipur condition, 2069/70

Treatments	Plant harvest. (No.)	Tuber size distribution (No. wt/plot)						Tuber no./plot	Yield/plot (kg)
		Under size		seed size		Over size			
		No.	wt.(kg)	No.	wt.(kg)	No.	wt.(kg)		
V1T1	50	273.0	3.03	340.3	16.80	50.0	6.30	663.3	26.13
V1T2	49	337.7	3.23	280.3	14.80	38.3	4.77	656.3	22.80
V1T3	50	270.3	2.67	311.3	16.37	79.3	6.33	661.0	25.37
V1T4	50	283.0	2.77	384.3	17.37	39.7	4.80	707.0	24.93
V1T5	48	264.7	3.17	369.7	18.40	44.0	6.33	678.3	27.90
V2T1	50	240.3	2.30	247.7	8.70	16.3	1.60	504.3	12.60
V2T2	50	208.3	2.07	253.3	11.90	22.7	2.30	484.3	16.27
V2T3	49	191.7	2.20	286.7	13.00	31.7	3.83	510.0	19.03
V2T4	50	187.0	2.27	350.0	15.97	37.3	4.23	574.3	22.47
V2T5	50	315.0	3.07	472.0	18.43	25.7	2.67	812.7	24.17

Plot size: 7.5 m^2 (3 m x 2.5 m)

V1 = Kufri Jyoti, V2 = Janak Dev; T1: Covered by insect proof net, T2: Only spraying of appropriate insecticides when aphid population reaches critical, T3: Only rouging of infected plant (Negative selection), T4: Spraying of appropriate insecticides and rouging of infected plant (Negative selection) (2+3), T5: No spray and rouging (control)

Table 5.9: Virus status by DAS-ELISA test of the potato planted under degeneration studies at RARS, Parwanipur condition, 2069/70

Treatment	Potato virus infection tested by DAS-ELISA					
	PLRV	PVA	PVM	PVS	PVX	PVY
V1T1	0.173	0.071	0.084	0.064	0.076	0.090
V1T2	0.196	0.086	0.122	0.075	0.077	0.124
V1T3	0.256	0.091	0.098	0.076	0.080	0.125
V1T4	0.138	0.084	0.080	0.067	0.076	0.087
V1T5	0.132	0.064	0.088	0.072	0.065	0.096
V2T1	0.159	0.071	0.1019	0.068	0.079	0.106
V2T2	0.185	0.091	0.096	0.087	0.073	0.089
V2T3	0.166	0.084	0.082	0.069	0.062	0.087
V2T4	0.162	0.070	0.084	0.071	0.061	0.091
V2T5	0.188	0.072	0.089	0.070	0.073	0.104
Negative control (OD)	0.129	0.056	0.075	0.061	0.059	0.098

Plot size: 7.5 m2 (3 mX2.5 m)

V1 = Kufri Jyoti, V2 = Janak Dev; T1: Covered by insect proof net, T2: Only spraying of appropriate insecticides when aphid population reaches critical, T3: Only rouging of infected plant (Negative selection), T4: Spraying of appropriate insecticides and rouging of infected plant (Negative selection) (2+3), T5: No spray and rouging (control)

3.1.5.4 Survey and surveillance of virus on different seed standard at different research station and farms

Seed producer groups, farmers or stations situated under different agro-ecological zones should know how long (number of generations) can be multiplied PBS as quality source seeds for ware potato production for their respective zones/areas. Similarly, in the case of seed production at Farm/Station also should know the quality of seed stock. Such type of survey activity may help for the optimum utilization of valuable pre-basic as well as basic seeds for seed production purpose and also ensures the availability of quality seeds for ware potato producers.

Immediately after establishment of the laboratory and production of the PBS, most of the RARS and ARS had started to use the high quality seed for the production of the quality basic seed for their own seed production program and or for distribution to the respective regions. Since long, there is lack of systematic seed quality maintenance program and supervision program. Keeping this in mind, NPRP is started to train the staffs and observed the field where basic seed is producing. During surveying period, total six research stations were visited and collected some basic information. In the first stage, mainly diseases and pests were recorded under field condition and in the second stage the collected sample seed were bought to

NPRP for serological test of potato viruses. The field observation result is presented in table 5.10 and virus reaction from laboratory test is presented in table 5.11. Maintaining the generation of the seed is the most important and difficult too. At present, this is lacking in most of the seed producer partners. In the case of virus identification in field observation and laboratory test were found similar results on virus status (Table 5.10 and 5.11). Mainly, local cultivars were found high percentage of virus infection in most of the served locations.

Table 5.10: Disease (mainly virus) and insect status of the potato grown under different Research Stations by using PBS under field conditions, 2069/70

Research Station/ Farm	Altitude (masl)	Target (mt)	Seed standard	Variety	Amount planted (Kg)	Diseased	Insects	Remarks
RARS Tarahara	150 m	6.0	BS-3	K. Sinduri	300	PLRV, Scab, EB	-	
			BS-2	Janak Dev	400	EB	-	
			BS-2	Cardinal	500	EB		
			BS-2	K. Rato	800 No.	LB	-	
			BS-2	IPY-8	700 No.	LB	-	
ARS Belachapi	125 m	0.15	-	8 varieties	25	-		
RARS Parwanipur	100 m	5.0	-	C 140		Virus	Aphid	Generation not maintained
			-	K. Sinduri		PLRV	-	
			BS 3	Janak Dev		-	-	
			-	Janak Dev		-	-	
ARS Malepatan		5.0	BS 2	K. Jyoti		-		
			PBS	Desiree		-	-	
			BS 2	Janakdev		-	-	
			-	BR63-65		-	-	
RARS Nepalgunj			BS 3	Desiree	50 kg	-	-	
			-	K Jyoti	50 kg	-	-	
			-	Cardinal	50 kg	-	-	
			-	K Sindhuri	50 kg	Virus	Aphid	
ARS Dailekha	1255		BS 3	Cardinal		-	-	
			BS 3	K Jyoti		-	-	

Table 5.11: Status of potato viruses tested by DAS-ELISA technique potato grown using PBS under different Research Stations, 2069/70

Location	Cultivar	Level of basic seed	Potato virus infection tested by DAS-ELISA					
			PVX	PVY	PLRV	PVA	PVM	PVS
RARS Tarahara	Cardinal	BS-2	0.081	0.110	0.081	0.076	0.077	0.094
	Janakdev	BS-2	0.094	0.099	0.094	0.075	0.094	0.086
	HPS II/67	-	0.086	0.131	0.086	0.085	0.086	0.093
	K. Sindhuri	BS-3	0.06	0.099	0.176	0.105	0.074	0.076
	K. Rato	BS-2	0.091	0.092	0.094	0.076	0.094	0.085
ARS Belachapi	K. Jyoti	BS-3	0.099	0.114	0.076	0.094	0.091	0.135
	Local	-	0.142	0.083	0.176	0.186	0.086	0.076
	L-235.4	-	0.092	0.075	0.085	0.067	0.093	0.094
RARS Parwanipur	C 140	-	0.397	0.138	0.267	0.094	0.127	0.086
	Janakdev	BS-3	0.074	0.102	0.076	0.086	0.068	0.077
	K. Sindhuri	-	0.247	0.209	0.152	0.094	0.096	0.179
ARS Malepatan	K. Jyoti	BS-2	0.070	0.120	0.086	0.086	0.076	0.085
	BR63-65	-	0.076	0.146	0.094	0.092	0.150	0.129
	Desiree	BS-1	0.087	0.075	0.086	0.076	0.073	0.081
	Janakdev	BS-2	0.060	0.078	0.06	0.094	0.094	0.093
RARS Nepaljung	Cardinal	BS-3	0.059	0.059	0.099	0.086	0.126	0.086
	K. Jyoti	-	0.071	0.06	0.081	0.080	0.143	0.065
	K Sindhuri	-	0.066	0.065	0.148	0.086	0.085	0.076
	Desiree	BS-3	0.096	0.068	0.086	0.060	0.067	0.076
ARS Dailekh	Cardinal	BS-3	0.064	0.103	0.076	0.076	0.095	0.093
	K Jyoti	BS-3	0.137	0.068	0.145	0.095	0.086	0.141
Negative control (OD)	-	-	0.066	0.065	0.063	0.061	0.063	0.062

Threshold value ≥ Average value of healthy control x Standard deviation

3.1.5.5 Virus elimination of promising clones and farmers most preferred cultivars

At the end of this fiscal (2069/70) year or immediately after harvest, potato variety ROSITA was received from Dolakha district for virus elimination purpose. After breaking tuber dormancy, stepwise virus elimination work has been carried out under laboratory conditions. Rosita is the most popular and growing since late 1970's at major part of Dolakha and Sindhupalchok district. Farmers from those

areas demanding PBS for long, but we could not produce mainly because that variety is highly susceptible to wart disease. Finally, NPDP (DoA) Khumaltar also requested for producing PBS of Rosita. For this purpose, this unit received three samples from Hattiban for virus elimination. Last fiscal year, the tissue culture laboratory was heavily contaminated and slowly it has some improvement. Recently, one sample form Dolakha and three samples from Hattiban have been already transferred to *in vitro* condition for virus elimination purpose. In the next step, meristem tips excision will be carried out for virus elimination. Still there is some problem in the laboratory i.e. some contamination of laboratory room because of last year's water leakage, lack of genuine equipments and lack of trained main power especially on virus elimination and testing.

3.1.6 Improving food security and nutrition of rural people in Nepal and Bhutan through collaborative potato breeding for yield stability and micronutrient density

Introduction

This is ADA/CIP-funded three years project in Nepal. Bhutan Potato Development Project (BPDP) implements this project in Bhutan, Li-Bird one of the NGOs working in Nepal implements in Jumla and NPRP/NARC implements its activities in Khumaltar and this project in Dolakha and Sindhupalchok districts of central Nepal. To get extension workers, researchers, consumers and farmers acquainted with participatory evaluation of the nutrient-rich potato clones and improved potato production technology at the time of planting, flowering and at harvest were conducted at Nucleus Seed Potato Production Farm (NSPF) Nigaley, Sindhupalchok district. In all the trainings, the participants were from DADO Dolakha and DADO Sindhupalchok, NSPF Nigaley and selected potato farmers from Dolakha and Sindhupalchok districts and different disciplinary divisions and NPRP Khumaltar. It was to involve all the partners in participatory variety selection (PVS).

Materials and Methods

The seed materials necessary for Li-Bird Jumla and NPRP were multiplied at Hattiban Research Farm Khumaltar in the summer and ARS (Hort.) Pokhara in winter season respectively following recommended cultural practices.

One set of mother trial was planted at Nucleus Seed Potato Production Farm (NSPF) Nigaley, Sindhupalchok with 15 clones. Two sets of baby trials were planted in Kharidhunga area of Dolakha district and 2 sets in the periphery of Nigaley Farm in Sindhupalchok district. Number of clones planted was 15 in all the testing sites. Rosita, a highly popular variety in the locality was used as the check. Three participatory variety selection trainings were conducted 3 times, one before planting mother baby trials, another at the flowering stage and one at harvest. Thirty to thirty-five trainees participated the training. The participants were from NARC, DADO Dolakha, DADO Sindhupalchok, NSPF Nigaley and the potato farmers from both of the districts. The training was conducted for 3 days and covered theory and practical portions, both. The trainers were from NPRP and CIP New Delhi, India in all the times.

The tested clones were CIP395112.32, CIP393382.44, CIP395017.242, CIP390478.9, CIP399092.116, CIP394611.112, CIP393617.1, CIP393536.13, CIP399078.11, CIP395017.229, CIP393073.179, CIP394613.139, CIP392740.4, CIP395067.22 and Rosita. All other cultural practices were followed as per the

recommendations. The data gathered were from all of the 3 sets of trials was s following:

a. Growth parameters

1. Emergence (%) at 30 and 45 days after planting
2. Plant height (average of 5 plants/ clone)
3. Plant uniformity (after 6 weeks of planting at 1-5 scale)
4. Plant vigor (after 6 weeks of planting at 1-5 scale)
5. Number of main stems per plant (average of 5 plants), and
6. Late blight rating (using 1-9 scale)

b. Yield and Yield parameters

1. Number of plants harvested
2. Number and weight fraction of the tubers in three grades (small, medium and large)
3. Total number and weight of tubers/plot
4. Yield tons per hectare
5. Color, shapes and eye depth of the tubers

Results and Discussion

Hattiban activities

At Hattiban Potato Research Farm, two activities; true seed screening and clone multiplication work were carried out in the crop seasons. During the period of project planning, NPRP had received 18 bio-fortified potato clones from CIP Lima in advance and were maintained in in-vitro. They were field multiplied last year and the harvest was used in Mother and Baby trials planned for Dolakha in February, 2013. Same lot was given to Li-Bird Jumla activities also.

In the true seed trial, the seeds were from new stock so the dormancy breaking treatment was carried out with GA3, but did not emerge well, however, the harvested tubers are stored in the cold store for the utilization next season.

Field testing

The weather remained comparatively wet this year in Nigaley area therefore the growth and development of the crop was hampered little bit. In the results the check variety "Rosita" after 3, 4 decades of introduction in this area, still performed well and ranked second in almost all of the trials conducted (Table 6.1, 6.2, 6.3 and 6.4).

All the three participatory varietal selection (PVS) trainings were completed successfully and remained fruitful to the participants and organizers both. NPRP from the centre also actively participated Li-Bird activities of Jumla in the season.

Table 6.1: Plant characters of potato genotypes tested at Mother Trial,Dolakha 2069/70

Genotypes	Emergence (%)	Ground Cover (%)	Plant ht. (cm)	Stem/ plant (no.)	Late blight severity (%)
CIP395112.32	99	83	55	6	58
CIP393536.13	96	33	33	2	62
CIP392470.4	94	38	26	3	70
CIP393073.179	79	32	21	1	22
CIP399092.116	98	70	43	3	85
CIP393382.44	91	52	43	3	88
CIP394611.112	99	55	34	5	85
CIP393617.1	95	63	35	4	35
CIP399078.11	95	85	51	8	67
CIP397060.19	96	23	17	2	72
CIP395017.229	86	37	30	4	23
CIP395017.242	98	32	26	3	47
CIP394613.139	96	72	36	4	87
CIP399067.22	85	33	41	3	52
Rosita (check)	100	67	41	4	82
Mean	94.2	48.4	33.3	3.4	58.0
F-Test	NS	**	**	**	**
LSD (0.05)	14.9	16.1	8.4	1.8	25.2

In mother trial of NSPF Nigaley, results revealed that the plant emergence at 30 DAP was the highest (100%) in check variety Rosita and the lowest in CIP 393073.179 (79%) probably it is due to the wide adaptability of this variety in the locality. Clone CIP390478.9 had very poor performance. In rest of the tested clones, it remained in between (Table 6.1). The percent ground cover among tested clones varied from 23 in CIP 397060.19 to 85 in CIP 399078.11. Plants of clone CIP 395112.32 were comparatively taller in height measuring 55 cm followed by CIP 399078.11 (51 cm). The mean plant height of the tested clones was 33.3 cm. Average number of main stems were counted highest (8) in CIP 399078.11 followed by clone CIP 395112.32 (6) and lowest (1) in CIP 393073.179. Clone CIP 393073.179 and CIP 395017.229 were found moderately late blight resistant clones, whereas all other as susceptible.

Number and weight of marketable tubers per plot was obtained highest in the clones CIP 395017.229 (161) and 395112.32 (13.0 kg), respectively (Table 6.2). Non-marketable tubers per plot were counted highest (266) in the clone CIP 399067.22

followed by CIP 394611.112 (263), CIP 395017.229 (205) and CIP 393617.1 (202), respectively.

Total weight per plot was produced highest (15.2 kg) by the clone CIP 395112.32 and lowest (1.7 kg) in CIP390478.9. Total weight per plot ranged from 0.1 kg to 0.5 kg in the trial. Yield was adjusted highest (28.5 t/ha) in the clone CIP395112.32 followed by CIP395017.229 (27.6 t/ha) and CIP393073.179 (24.5 t/ha) respectively (Table 6.2). Only the clones CIP 394611.112, CIP 394613.139 were superior to the local check (Rosit). Majority of all other clones tested in the trial produced less yield than in check variety Rosita (13.6 t/ha).

In the case of plant maturity, clones CIP390478.9, CIP394613.139 and CIP 399067.22 were observed early maturing, CIP393073.179, CIP399093.116, CIP394611.112 and 397060.19 were medium and all the remaining as late in the trial (Table 2). Marketable yields of Rosita, a check variety was inferior to CIP 395112.32, CIP 392470.4, CIP393073.179, CIP 394611.112, CIP399078.11 CIP395017.229, CIP395017.242 and CIP394613.139.

Same potato genotypes were tested as baby trials in 4 different farmers' fields of Dolakha and Sindhupalchok districts. Though all the clones tested had better emergence in farmers' fields, as in mother trial the check variety Rosita had highest emergence (100%). Percent ground cover was highest in the clone CIP 399092.116 (91) and lowest (18) in clone CIP390478.9.

Table 6.2: Yield characters of potato genotypes tested at Mother Trial, Dolakha 2069/70

Genotypes	Market tuber/ plot (no)	Market wt./plot (kg)	Non-market. tuber/plot (no.)	Total wt/plot (kg)	Adjusted yield (t/ha)	Market Yield (t/ha)	Mat urity
CIP395112.32	98	13.0	99	15.2	**28.5**	**24.3**	L
CIP393536.13	60	3.2	54	4.3	8.2	6.2	L
CIP392470.4	134	5.4	69	6.7	13.3	10.6	L
CIP393073.179	102	6.9	55	9.3	**24.5**	**17.6**	M
CIP399092.116	46	1.7	181	3.7	7.1	3.3	M
CIP393382.44	79	3.6	79	4.7	9.7	7.4	M
CIP394611.112	131	5.6	263	9.1	17.0	10.6	M
CIP390478.9	35	1.0	76	1.7	3.2	1.9	E
CIP393617.1	83	4.2	202	7.3	14.2	8.1	L
CIP399078.11	106	4.4	87	7.0	13.7	8.8	L
CIP397060.19	75	4.2	75	5.7	10.9	8.1	M
CIP395017.229	161	9.5	205	12.6	**27.6**	**20.9**	L
CIP395017.242	81	5.5	72	7.0	13.2	10.4	L
CIP394613.139	116	6.8	93	9.0	17.3	13.1	E
CIP399067.22	51	1.9	266	4.7	10.6	4.3	E
Rosita (check)	82	4.6	181	7.5	13.6	**8.6**	
Mean	96.3	5.1	135	7.2	14.6	10.2	
F-Test	**	**	**	**	**	**	
LSD (0.05)	46.8	2.1	70.0	2.1	6.3	4.9	

Plants of clone CIP399092.116 were taller (48 cm) than all the clones tested followed by CIP 399078.11. Average numbers of main stems per plant were counted highest (5) in CIP399078.11 and lowest (1) in CIP3990478.9. Severity of late blight disease was measured the highest (74%) in the clone CIP 390478.9 and lowest (25%) in CIP395017.229 and CIP 395017.229. Variety Rosita was scored second in late blight susceptibility in the trial scoring 73%.

Table 6.3: Plant characters of potato genotypes tested at Baby Trial, Dolakha, 2069/70

Genotypes	Emergence (%)	Ground Cover (%)	Plant ht. (cm)	Stem/ plant (no.)	Late blight severity (%)
CIP395112.32	94	86	42	4	40
CIP393382.44	94	71	36	3	68
CIP395017.242	98	39	23	3	56
CIP390478.9	92	18	4	1	74
CIP399092.116	97	91	48	4	63
CIP394611.112	98	80	39	4	54
CIP393617.1	92	74	36	3	40
CIP393536.13	97	69	34	2	51
CIP399078.11	95	88	47	5	25
CIP395017.229	95	65	33	4	25
CIP393073.179	91	48	23	2	53
CIP394613.139	98	86	36	3	69
CIP392740.4	95	50	20	3	70
CIP395067.22	92	33	21	2	60
Rosita (check)	100	85	39	4	73
Mean	95.3	65.4	32	3.0	54.6
F-Test	NS	**	**	**	NS
LSD (0.05)	6.5	22.5	11.2	1.2	37.3

Except in the emergence and late blight disease severity, a highly significant different was observe in all the vegetative parameters tested (Table 6.3).

Average numbers of marketable tubers were counted highest (96) in variety Rosita (Table 6.4), whereas in the tested clones it ranged from 21 to 87. Highest weight of marketable quality tubers were recorded in the clone CIP 395112.32 (6.4 kg) followed by CIP 395067.22 (5.7 kg), respectively. As in mother trial, the performance of clone CIP 390478.9 was poorer in the baby trials also (Table 6.4). Clone CIP 399092.116 had highest number of non-marketable type of potato tubers. Total weight per plot and per plant was obtained highest yield from the clone CIP395112.32, which influenced tuber yield tons per hectare. The clone CIP395112.32 was the highest yielder (35.7 t/ha) followed by Rosita (27.5 t/ha).

Table 6.4: Yield characters of potato genotypes tested at Baby Trial, Dolakha 2069/70

Genotypes	Market tuber/ plot (no.)	Market. wt./plot (kg)	Non-market tuber/plot (no.)	Total wt/plot (kg)	Total wt./plant (kg)	Adj. yield (t/ha)	Wart	Maturity
CIP395112.32	78	6.4	36	8.1	0.5	**35.7**	+	L
CIP393382.44	36	1.8	26	2.4	0.1	10.2	+	M
CIP395017.242	37	2.2	17	2.7	0.1	11.7	+	L
CIP390478.9	24	0.9	14	1.1	0.1	4.9	-	E
CIP399092.116	43	1.7	51	2.2	0.1	9.7	-	M
CIP394611.112	87	4.2	33	4.6	0.2	19.3	-	M
CIP393617.1	47	1.9	43	2.6	0.1	11.7	+	L
CIP393536.13	38	2.2	15	2.4	0.1	10.4	+	E
CIP399078.11	52	2.3	48	3.1	0.2	13.4	+	L
CIP395017.229	54	2.4	46	3.5	0.2	14.9	+	L
CIP393073.179	33	3.5	13	4.4	0.2	**19.8**	+	M
CIP394613.139	62	1.4	32	4.3	0.2	18.3	-	E
CIP392740.4	21	1.3	28	2.4	0.1	10.2	+	E
CIP395067.22	35	5.7	30	1.7	0.1	8.1	+	E
Rosita (check)	96	2.7	43	6.6	0.4	**27.5**	+	L
Mean	49.4	2,8	31.5	3.5	0.2	15.1		
F-Test	**	**	**	**	**	**		
LSD (0.05)	25.7	1.7	19.4	2.1	0.1	9.2		

The highest marketable yield per plant and marketable yield tons per hectare was highest in the clone CIP395112.32. Rosita was second highest marketable tuber yielder in the trial. Except clones CIP390478.9, CIP399092.116, CIP394611.112 and CIP394613.139, all other clones tested in the baby trials were observed wart disease susceptible. The clones CIP390478.9, CIP393536.13 and CIP394613.139, all other clones tested in the trials were wart susceptible.

3. 1. 7 Potato Diseases

3. 1. 7. 1 Late blight

3. 1. 7. 1. 1 Initial Evaluation of potato clones against late blight

A total of 46 potato clones were evaluated against late blight disease. Emphasis was given to late blight resistance along with higher yield and red skinned clones as desirable character. The performance of the clones compared with released and recommended cultivars Janakdev, Desiree and Kufri Jyoti.

The experiment was planted during autumn season which provides most conducive atmosphere for late blight disease development at Hattiban Farm, Khumaltar, Lalitpur. Plot size was 2.5 m X 0.6 m (1.5 m^2) with two replications. Single row of susceptible variety Desiree was planted on both sides of experimental plots to exert more disease pressure. Compost 20 t/ha and chemical fertilizer was applied at 100: 100: 60 Kg NPK/ha as basal. Row to row distance 60 cm and plant to plant 25 cm maintained. Irrigation was applied at 40 and 60 days after planting followed by weeding and earthing-up. No fungicides were sprayed throughout the crop period. Late blight damage was recorded as foliage damage % for five times starting from 40 up to 70 DAP.

Table 7.1: Initial evaluation of clones for resistance to late blight and tuber yield at Khumaltar, field conditions, 2069/70

Genotypes	Under Size		Seed Size		Over Size		Total		AUDPC
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	
PRP016367.7	17	0.18	42	1.85	21	2.95	80	4.98	0
PRP016567.1	18	0.20	44	2.15	21	3.00	83	5.35	0
PRP016567.2	35	0.25	74	2.95	11	1.35	119	4.55	0
PRP016568.3	37	0.35	81	3.55	18	2.28	135	6.18	0
PRP016567.5	24	0.15	38	1.85	20	2.85	81	4.85	0
PRP016567.6	34	0.40	76	3.20	27	2.75	136	6.35	0
PRP016567.10	63	0.40	59	1.95	4	0.55	126	2.90	0
PRP016567.11	25	0.10	54	2.05	14	1.35	93	3.50	0
PRP016567.12	22	0.25	57	2.55	14	1.70	93	4.50	10
PRP016567.12	30	0.43	57	2.10	19	2.45	106	4.98	0
PRP85861.8	88	0.80	102	3.50	17	1.55	207	5.85	0
LBr 40	23	0.18	40	1.90	21	3.20	83	5.28	0
PRP056267.1	34	0.28	63	2.60	19	2.65	116	5.53	0
PRP056267.6	44	0.35	73	3.15	21	2.70	138	6.20	0
PRP016267.9	63	0.50	93	3.65	12	1.50	168	5.65	0
PRP146267.6	22	0.20	45	2.38	23	3.80	90	6.38	0
PRP146267.7	30	0.35	73	2.90	33	4.35	135	7.60	0
PRP146267.8	39	0.38	51	2.25	23	3.45	113	6.08	0
PRP146267.11	23	0.20	38	1.95	34	5.05	94	7.20	0
CIP394050.110	28	0.30	78	3.10	10	1.10	115	4.50	248
Janakdev (Check	11	0.08	46	2.25	16	2.20	73	4.53	0
PRP226265.1	**94**	**0.75**	**90**	**3.50**	**33**	**4.20**	**217**	**8.45**	**0**
PRP226265.4	17	0.15	47	2.20	15	1.90	78	4.25	0
PRP226267.1	57	0.53	63	2.85	23	3.10	143	6.48	0
PRP226267.10	46	0.45	74	3.05	17	1.80	137	5.30	0
PRP226267.11	**48**	**0.35**	**99**	**4.15**	**28**	**3.55**	**174**	**8.05**	**0**
PRP226567.1	22	0.20	52	2.50	32	4.20	106	6.90	0
CIP399078.11	39	0.40	47	2.00	19	2.45	104	4.85	0
PRP226567.2	38	0.40	94	4.15	15	1.65	146	6.20	113
Kufri Jyoti (Check	19	0.18	34	1.43	11	1.53	64	3.13	1558
CIP393077.54	10	0.20	35	1.80	19	2.80	64	4.80	0
PRP286265.22	20	0.25	47	2.18	34	5.00	100	7.43	0
RPR286365.6	15	0.20	66	2.78	25	3.45	105	6.43	0
PRP296667.2	31	0.38	61	2.60	18	2.35	109	5.33	0
PRP296667.3	**49**	**0.43**	**82**	**3.65**	**32**	**4.45**	**163**	**8.53**	**0**
PRP296668.4	**21**	**0.20**	**80**	**3.45**	**35**	**4.45**	**135**	**8.10**	**0**
PRP296668.1	43	0.48	62	2.50	25	3.25	130	6.23	0
CIP391058.175	42	0.40	72	3.55	19	2.20	133	6.15	0
CIP393073.179	28	0.25	35	1.60	22	4.20	85	6.05	44
CIP393617.1	47	0.50	93	4.15	27	3.25	166	7.90	26
PRP25861.1	23	0.35	49	2.30	32	4.55	104	7.20	36
CIP385499.11	24	0.40	45	2.75	27	4.10	96	7.25	219
CIP395112.32	21	0.23	50	2.28	28	4.50	99	7.00	10
CIP395017.229	28	0.23	58	2.60	32	4.35	118	7.18	0
CIP395017.242	26	0.33	56	2.45	34	4.40	116	7.18	0
CIP399067.22	45	0.43	69	2.65	17	1.80	130	4.88	0
F- test	**	**	**	**	**	**	**	**	**
CV%	36.8	39.6	20.4	19.7	23.0	21.4	18.6	12.2	
LSD(0.05)	25.1	0.25	25.3	1.1	10.1	1.28	62.85	1.58	

Out of 46 tested clones most of the clones observed resistant to late blight disease. This could be due to the lack of ambient atmosphere for late blight development. Only susceptible check variety Kufri Jyoti showed significant difference with late blight resistance with highest AUDPC value (1558). Two clones CIP394050.110

and CIP395499.11 showed moderately resistant with AUDPC value 248 and 219 respectively. The lowest number of under sized, seed sized and over sized tubers observed in CIP393977.54 (10), Kufri Jyoti (34) and PRP016567.10 (4) respectively. The highest number of under sized, seed sized and over sized tubers observed in PRP26265.1 (94), PRP85861.8 (102) and PRP296668.4 (35) respectively (Table 7.1). Highest tuber yield obtained from RPP296667.3 (8.53 Kg) followed by PRP226265.1 (8.45 kg/plot), and PRP296668.4 (8.1 kg/plot) against the yields of Janakdev (4.53 kg/plot) and Kufri Jyoti (3.13 kg/plot).

3.1.7.1.2 Screening of potato clones against late blight at Nigale, Sindhupalchowk conditions

Experiment was carried out at Nigale, Sindhupalchowk (2450 masl) field condition in order to identify genotypes resistant to late blight and high yield for high hills. The experiment was laid in randomized complete block design with three replications. The plot size was 2.5 m X 0.6 m (1.5 m^2). Row to row distance was maintained at 60 cm and plants were 25 cm apart. Compost @ 20 t/ha and chemical fertilizer was applied at 100: 100: 60 Kg NPK/ha as basal. The trial was conducted in rain-fed conditions. Other cultural practices were carried out as per the requirements. Fungicides were not applied throughout crop period and late blight severity was recorded in percentage foliage damage at 7 to 10 days interval from the first date of symptoms appearance and continued up until susceptible check reaches 100 % foliage damage.

Altogether, 27 clones were screened against late blight resistance and high yielding capacity. Out of them eight clones viz. PRP85861.11 (20), LBr 40 (27), CIP384321.15 (28), CIP392657.8 (33), PRP266264.01 (43), PRP25861.1 (48), PRP85861.1 (48) and PRP276264.01 (77) found resistant to late blight with lowest AUDPC value (Table 7.2). Highest numbers of tubers were obtained from CIP394050.110 (82) and lowest from CIP385499.11 (11). The highest yield obtained from CIP394950.110 (4.03 kg) and lowest from BSUPO3 (0.47 kg) and CIP385499.11 (0.47 kg).

Table 7.2: Performance of potato genotypes to tuber number, yield and late blight severity (AUDPC) at Nigale field conditions, 2069/70

Genotypes	Under Size (No.)	Seed Size (No)	Over Size (No)	Total (No)	Yield(kg)/plot (1.5 m^2)	AUDPC
PRP35861.2	24	39	7	71	2.73	242
PRP85861.12	15	29	4	49	2.03	48
PRP25861.10	14	26	1	42	1.30	375
PRP225861.2	13	28	3	44	1.78	110
LBr 40	22	24	5	51	1.93	27
PRP85861.8	19	27	9	55	2.90	122
L 235.4	36	40	6	83	2.93	845
PRP276264.01	23	37	3	63	1.77	77
PRP266264.01	12	30	10	51	3.57	43
BSUPO3	9	9	1	19	0.47	300
Kufri Jyoti (Check)	26	51	4	81	2.80	908
CIP384321.15	14	41	1	55	1.73	28
PRP25861.1	6	17	2	24	0.87	48
CIP388580.6	20	41	9	69	3.47	833
CIP394050.110	19	53	10	82	4.03	883
CIP393385.39	14	36	2	53	2.00	358
PRP266264.15	32	40	2	75	2.02	108
Janakdev (Check)	13	25	6	43	2.13	392
CIP393280.57	14	28	7	49	2.97	475
PRP25861.11	20	30	3	53	1.70	93
PRP85861.11	19	35	7	61	2.83	20
CIP393077.54	36	41	1	79	1.97	467
CIP392657.8	4	26	10	40	3.31	33
CIP385499.11	2	8	1	11	0.47	675
CIP389746.2	12	42	5	59	2.67	517
CIP392661.18	4	13	3	20	1.10	492
Rosita (Check)	14	25	3	42	1.71	825
F- test	**	**	**	**	**	**
CV %	55.65	31.75	68.77	31.23	31.59	40
LSD (0.05)	15.49	16.17	5.238	26.97	1.133	225

3.1.7.1.3 Rational application of fungicides

Late blight caused by *Phytophthora infestans* (Mont) de Bary, is a devastating disease of potatoes worldwide. The continuing changes in populations of *P.*

infestans world-wide have made the management of late blight increasingly difficult. Late blight is one of the most important biotic constraints to potato production causing substantial yield loss each year in Nepal.

Reducing fungicide use by growing resistant cultivars could decrease environmental contamination, risk to human health and increase the economic benefits for farmers. In Kathmandu valley, efficacy of phenylamide fungicides has reduced in recent year, either because of poor quality of the product or prevalence of metalaxyl insensitive strains of *Phytophthora infestans*. Out of eight fungicides (dimethomorph, fluazinam, phosphonate, fenamidon, phenylamide, mancozeb, propineb and chlorothalonil) tested in 2011, fenamidon containing fungicide (Sectin) was found to be one of the most effective fungicides in controlling late blight under Kathmandu valley conditions.

Potatoes are planted at two times in the Kathmandu valley, September and January. Cull piles of infected tubers, together with volunteer plants serve as primary sources of inoculums for disease initiation. Disease becomes severe on susceptible hosts in conducive weather conditions. Under such conditions, a high frequency of fungicide applications is needed for susceptible cultivars, although farmers use the same spray doses and frequencies for all potato varieties without considering the levels of resistance. There are several potential methods for reducing fungicide inputs in potato crop to manage late blight, that include less active ingredient, reduced application rates, longer application intervals along with combination of resistant cultivars.

The objectives of this study were to determine the efficacy of reduced frequency and increased spray intervals of Sectin for two promising genotypes L235.4 and CIP389746.2 compared with officially released commercial potato varieties of known levels of resistance, Kufri Jyoti (highly susceptible) and Janakdev (moderately resistant), for achieving considerable tuber yield.

Materials and Methods

Experiments were conducted in 2011 and 2012 at Khumaltar, Lalitpur located at the latitude 27.647039 N, longitude 85.334103 E and at an elevation of 1360 masl. Average precipitation of the two experiment years, during the disease development period (17 Sept-16 Dec) was 109 mm with average minimum and maximum temperatures of 10.8° and 23.8° C, respectively. The September planting season is the most conducive for late blight development, and in this season infection starts within 30 days after planting (Table 7.3) and the severity reaches >90 percent, so that additional inoculation is not required.

Table 7.3: Dates of major operations performed in 2011 and 2012

Operations	2011	2012
Planting	12 Sept.	7 Sept.
Start and end of spray	8 Oct and 14 Nov	4 Oct and 10 Nov
First irrigation	15 Oct.	20 Oct.
Second irrigation	30 Oct.	10 Nov.
Observations	23 Oct, 30 Oct, 6 Nov, 13 Nov and 20 Nov	19 Oct, 26 Oct, 2 Nov, 9 Nov and 16 Nov
Harvest	19 Dec.	20 Dec.

Experiments were conducted as two-factor factorial in a randomized complete block design, comprising 16 treatment combinations in three replications. One factor was genotypes and the other was fungicide spray frequencies. Four genotypes were used; of which two were promising genotypes L235.4 and CIP389746.2 and the other two were released varieties, Kufri Jyoti and Janakdev of known levels of late blight resistance with values of 9.0 and 4.4, respectively. Three spray frequencies, i.e. 2, 4 and 6 times at intervals of 18, 9 and 6 days, respectively, were used comparing with no spray. Plot size was 2.4 m x 2.5 m (6 m^2) with a planting distance of 60 cm between and 25 cm within rows. A one-meter space was left between the plots and blocks to minimize fungicide spray drift. Fertilizers, di-ammonium phosphate, urea and muriate of potash were applied at the time of planting to supply 100:100:60 kg of N, P_2O_5 and K_2O ha^{-1}, respectively. Chemical fertilizers were applied in furrows and farm yard manure (FYM) 20 t ha^{-1} was placed on top of fertilizers. Sprouted tubers were planted above the FYM and covered with 5-6 cm soil layer making medium height ridges.

The fungicide 'Sectin' (a.i. 10% fenamidon + 50% mancozeb) manufactured by Bayer Crop Science India was used. Spraying was done after the initiation of late blight symptoms in the experimental plots. Sectin, 1.2 kg (commercial product), suspended in 800 liter water ha^{-1}, was used in each spray. Manually operated two liter capacity plastic sprayers were used for spraying. As per the spray schedule, spraying was started at 26-27 days and ended at 62-63 days after planting (DAP) in order to protect the crops for 36 days (up to 75 DAP).

Disease evaluation and data analysis

As soon as the late blight symptoms were detected, the first spray was applied. The first assessment of percent foliage damage was made on the two middle rows of each plot at 15 days after the first spray. Thereafter, each plot was visually evaluated for percent foliage damage at 7-8 days intervals, continuing for five successive observations.

Late blight severity data (percent foliage blight) were converted to the area under disease progress curve (AUDPC), using the following formula

$$AUDPC = (T_{i+1} - T_i) * \left[\frac{(D_{i+1} + D_i)}{2}\right]$$

where T was the time in days at i^{th} observation and D was the estimated percentage of area of blighted foliage at i^{th} observation.

Susceptibility to *P. infestans* was quantified in each cultivar using the interval scale (0-9) of Yuen and Forbes (2009), which was derived from the AUDPC. For this scale, a susceptible cultivar must be assigned a scale value. In this case, Kufri Joyti was assigned a value of 9 and the other values were calculated for each separate block within each experiment using the following formula.

$$\text{Scale value } (0-9) = \frac{\text{of genotype in question}}{\text{AUDPC of Kufri Joyti}} \text{X } 9.0$$

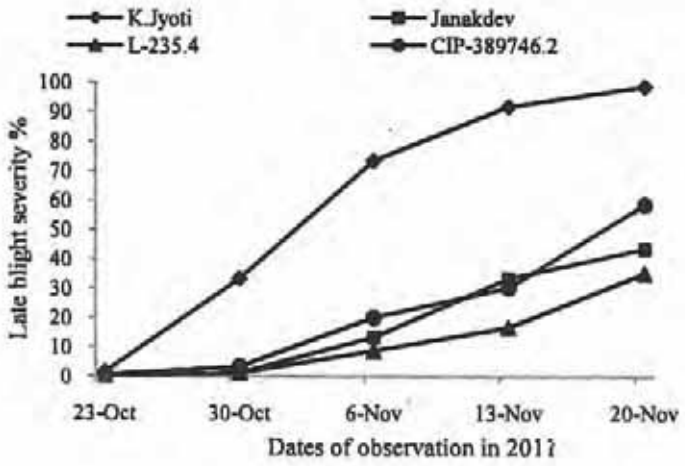
We note that while this is generally a 0-9 scale, any evaluated genotype with an AUDPC greater than that of Kufri Joyti will have a value greater than 9.

Potato fresh tuber yields were standardized as t ha^{-1}. The susceptibility scale value and total tuber yield were subjected to analysis of variance (ANOVA) to evaluate treatment effects on these variables using GenStat Discovery Edition 4 developed by VSN International Ltd.

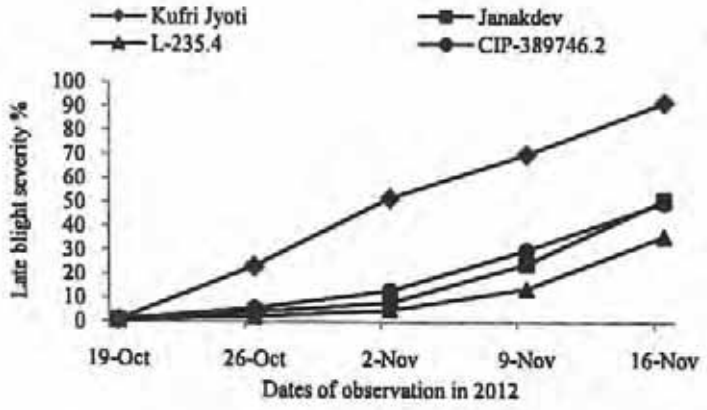
Results

Disease development

The first late blight symptoms were observed at 25-26 DAP. Disease severity in unprotected Kufri Jyoti (susceptible cultivar) reached up to 98% in 2011 (Figure 7.1A), whereas during the second year severity was 92%. Disease progress on CIP389746.2 was almost the same as that of Janakdev in both years. Genotype L235.4 showed significantly lower disease progress as compared to other three genotypes.



[A]



[B]

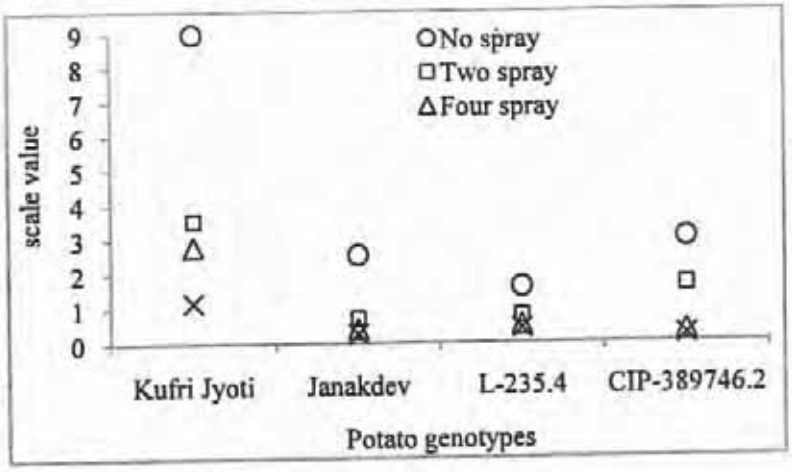
Fig.7.1. Late blight disease progress curves of potato genotypes grown without fungicide protection during the cropping seasons of years 2011 [A]and 2012 [B] at Khumaltar

Overall, disease severities were low in 2012 on all the test genotypes until the first week of November (Figure 7.1B). The genotypes clearly differed in their level of susceptibility to *P. infestans* and the difference was consistent in the two consecutive seasons.

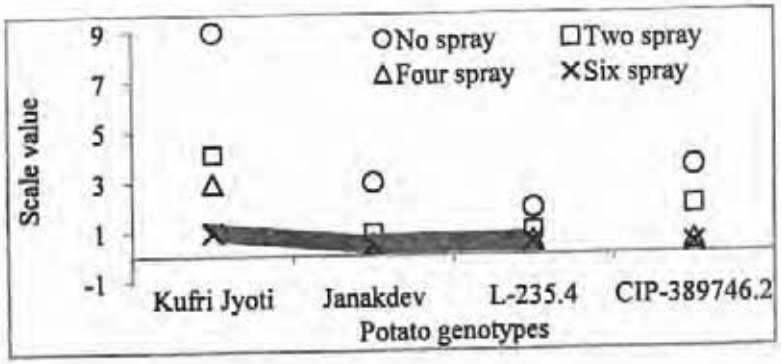
Optimum spray frequency for different host resistance levels

The effect of fungicide treatment on disease severity on the four potato genotypes followed a similar trend in both 2011 (Figure 7.2A) and 2012 (Figure 7.2B) under the prevailing weather conditions (Figures 7.5A and 7.5B). However, there were differences among the genotypes for their disease control levels due to fungicide

application. The scale values of the susceptible variety Kufri Jyoti decreased proportionally with increasing fungicide application up through six sprays (Figures 7.2A and 7.2B). In contrast, two, four and six sprays gave similar adequate control for Janakdev and L-235.4, whereas CIP–389746.2 required four or six sprays for adequate control.



[A]



[B]

Fig. 7.2 Disease severity in scale values (0-9) on four genotypes after different spray frequencies in 2011 [A] and 2012 [B] at Khumaltar

Visually, a similar pattern was observed for total tuber yield for the two years (Figures 7.3A and 7.3B). There was a continuous increase in yield for the susceptible cultivar with increasing fungicide application up to 6 sprays. With Janakdev and L235.4, this increase occurred most with the change from zero to two sprays; there was smaller increase in yield when one increased fungicide frequencies to four or six sprays. Finally, with CIP-38746.2, increases were evident up through four sprays, but less with the increment to six sprays.

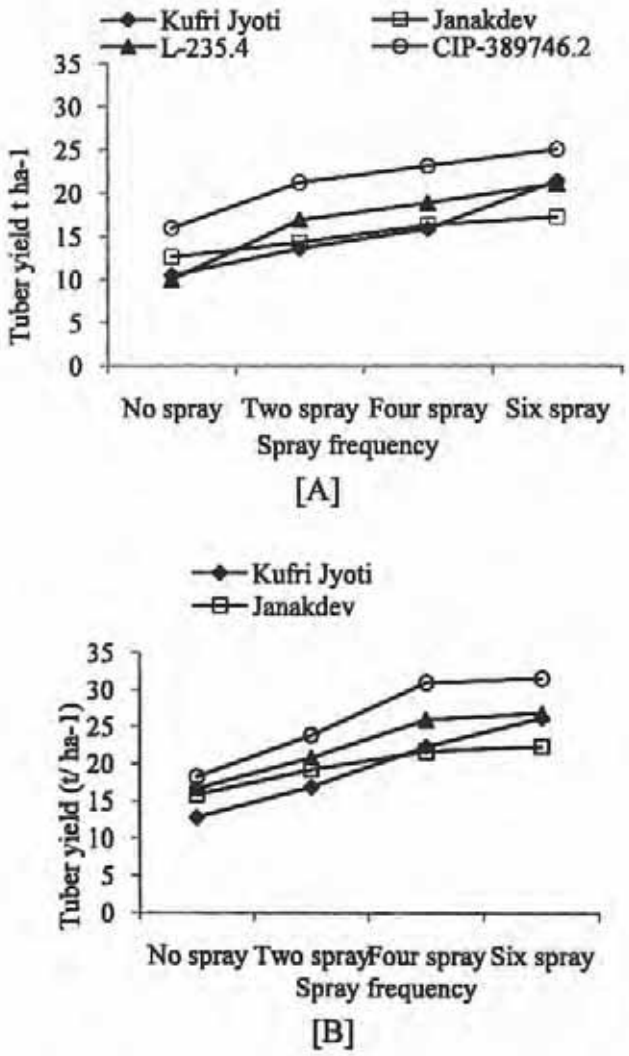


Fig.7.3 Effects of different fungicide spray frequencies on yield of four potato varieties grown in Khumaltar in 2011 [A] and 2012 [B]

The graphical interpretation was consistent with the means comparison from the ANOVA analyses of both disease severity levels (Table 7.4) and yield (Table 7.5). For the susceptible control, Krufri Jyoti, all treatments had significant effects in reducing severity and increasing yield. For Janakdev, L-234.4 and CIP-389746.2 two, four or six sprays caused a significant increase from no spray, but the treatments four and six-spray could not be distinguished statistically for both disease severity and yield.

Table 7.4: Effects of spray frequencies on disease severity (scale value) of different levels of resistant genotypes, mean of two years 2011 and 2012

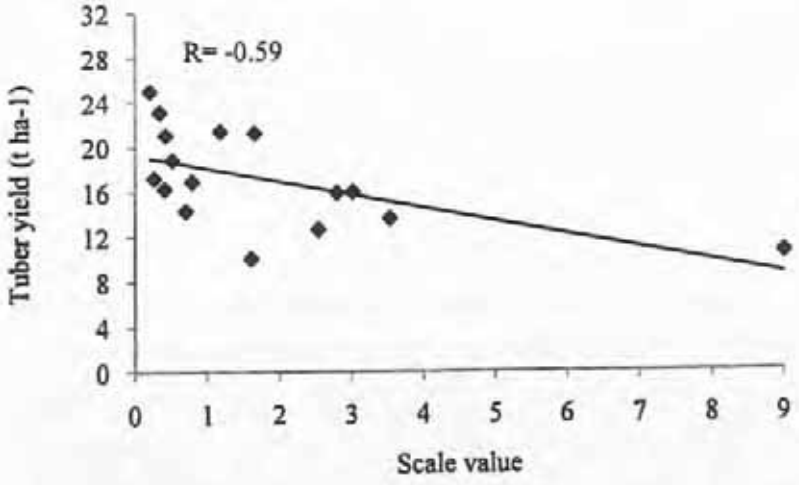
Spray frequency	Kufri Jyoti	Janakdev	L-235.4	CIP-389746.2
No spray	9.0 a	2.7 a	1.7 a	3.3 a
Two spray	3.8 b	0.8 b	0.9 b	1.8 b
Four spray	2.9 c	0.4 c	0.5 c	0.4 c
Six spray	1.1 d	0.3 c	0.5 c	0.3 c

CV= 12.5%; LSD (0.05) = 0.3; P= 0.001; DMRT comparison within the variety

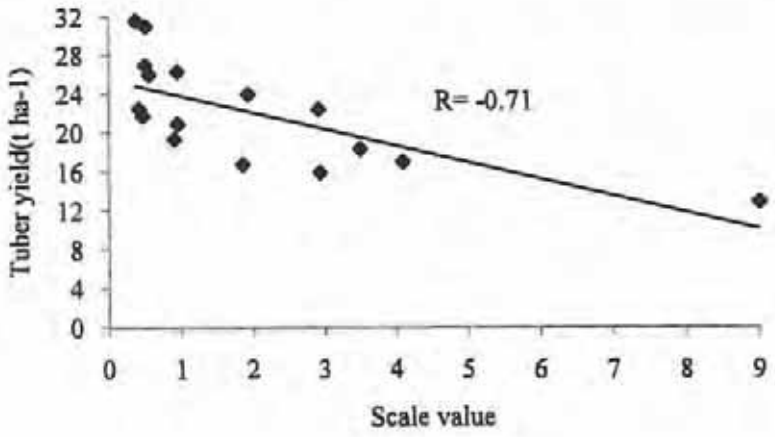
Table 7.5: Effects of spray frequencies on the tuber yields (t ha^{-1}) of 4 different levels of resistant genotypes, mean of two years 2011 and 2012

Spray frequency	Kufri Jyoti	Janakdev	L-235.4	CIP-389746.2
No spray	11.68 a	14.27 a	13.39 a	17.14 a
Two spray	15.28 b	16.79 b	18.88 b	22.57 b
Four spray	19.13 c	19.00 c	22.42 c	27.05 c
Six spray	23.84 d	19.83 c	23.99 c	28.29 c

CV = 8.0 % ; LSD(.05) = 1.8; P = 0.001, DMRT comparison within the variety



[A]



[B]

Fig. 7.4 Correlation between disease severity (scale value) and tuber yields of four potato genotypes evaluated over two years, 2011 [A] and 2012[B] in Khumaltar

The correlation coefficient of disease severity and the tuber yield was significant (R = -0.59) (Figure 7.4A) in 2011 and R= -0.71 in 2012 (Figure 7.4B).

Discussion

In the present study, the widely adopted potato cultivar Kufri Jyoti was used as susceptible check. Before 1974, it was reported to be resistant to late blight in India. Janakdev (CIP720123) was introduced from International Potato Center (CIP), and after several field tests, was released as a commercial variety in Nepal in 1999. Since then it has maintained a moderate resistance to late blight (3 to 4 on the 1-9 disease rating scale). The other two genotypes, CIP389746.2 introduced from CIP in 2001, and L235.4 by the McKnight Foundation, USA in 2002, were identified as promising genotypes and have been proposed for official release for commercial production.

The results of this study were consistent with previous studies indicating that a combination of genotype resistance and reduced fungicide frequency or dose will maintain foliar late blight to acceptable levels in most situations. Under extremely favorable environmental conditions for late blight development, the four sprays we found to be adequate may not be sufficient for satisfactory control even for moderately resistant genotypes. Thus, these results represent general trends and should not be taken as a recipe. Local adaptation is always advisable and under

disease favorable conditions even moderately resistant cultivars may need more than four sprays.

Instead of using phenylamides (metalaxyl) for late blight management, this study provides an alternative option of using Sectin (fenamidon +mancozeb) with a spray schedule based on a 9 days interval and a maximum of 4 sprays for attaining considerable tuber yield under Kathmandu valley conditions.

3.1.7.1.4. Participatory evaluation of late blight resistant potato genotypes

Farmers' participatory multi-location field experiments were carried out in 2012/13. Main objective of this experiment were evaluating and verifying late blight resistant and high yielding potato genotypes.

Twenty five promising potato genotypes which have been selected from series of experiments since 2006 were evaluated in farmers' field at Sharadanagar (Chitwan), Mainapokhar (Bardiya) and Kaski involving two to four farmers in each location. A farmers' field trial (FFT) set per farmer, composed of 6 to 8 genotypes, were planted in plot size 2.5 m X 1.2 m (3 m^2) during respective potato planting season. Janakdev in Chitwan and Nepalganj, MS 42.3 and Janakdev in Kaski were used as check to compare with test genotypes. Fungicides against any disease were not sprayed throughout the crop period. Late blight severity as foliage damage % was recorded at 70 days after planting. Crop was harvested at 90-110 days after planting depending upon the location and farmers' decision.

Bardia

Six new clones were evaluated against late blight and high yielding capacity at Mainapokhar, Bardia field conditions. Commercial variety Janakdev was used as a check. Recorded Late blight severity was far below its damaging level and all tested genotypes observed resistant to late blight. This could be absence of environment conducive for *Phytophthora infestans*.

Table 7.6: Performance of potato genotypes against late blight and yield under Mainapokhar, Bardia field conditions, 2069/70

Genotypes	Under Size (No.)	Seed Size (No)	Over Size (No)	Total (No)	Yield(kg)/ plot ($3m^2$)	Late blight severity (%)
PRP225861.2	75	111	10	196	6.92	4
CIP384321.15	61	149	13	223	9.17	5
CIP388580.6	21	65	9	95	5.08	4
PRP266264.15	51	143	17	211	10.58	2
CIP393077.54	18	62	30	109	9.03	3
CIP392657.8	27	62	24	113	7.95	4
Janakdev	22	92	32	146	9.06	4
F test	*	NS	*	NS	NS	
CV%	48.7	46.1	40.3	36.3	30.2	
LSD (0.05)	37.3	-	12.7	-	-	

Highest numbers of seed sized tubers were obtained from CIP384321.15 (149) and lowest number obtained from CIP393077.54 (62) and CIP392657.8 (62). Highest total tuber yield was obtained from PRP266264.15 (10.58 Kg) followed by CIP384321.15 (9.17 kg) and lowest from CIP- 388580.6 (5.08 Kg) (Table 7.6).

Table 7.7: Performance of potato genotypes against late blight and yield under Sharadanagar, Chitwan field conditions, 2069/70

Genotypes	Under Size (No.)	Seed Size (No)	Over Size (No)	Total (No)	Yield(kg)/ plot ($3m^2$)	Late blight severity (%)
PRP225861.2	18	92	6	117	3.78	5
PRP85861.8	104	116	9	229	5.87	2
CIP384321.15	29	107	10	146	5.43	1
CIP393385.39	81	94	8	183	5.47	10
PRP266264.15	65	120	14	200	6.27	5
CIP393280.57	69	77	2	147	2.90	3
PRP85861.11	86	102	13	201	6.23	3
CIP392657.8	20	60	2	82	2.70	5
Janakdev	36	95	12	143	5.50	10
F- test	*	*	NS	*	*	
CV%	56.6	21.4	68.8	29.51	26.9	
LSD(0.05)	58.54	36.04		84.29	2.28	

Chitwan

Eight new lines were tested against late blight and high yielding capacity along with commercial variety Janakdev in Sharadanagar, Chitwan field conditions. Late blight severity observed far below its damaging level. This must be due to lack of environment conducive for *Phytophthora infestans*. Highest tuber yield was obtained from PRP266264.15 (6.27 kg) followed by PRP85861.11 (6.23 kg) and lowest from CIP-392657.8 (2.7 Kg) (Table 7.7).

Kaski

Six genotypes were tested against late blight resistance and high yielding capacity at Malepatan, Kaski field conditions. Commercial varieties Janakdev and MS 43.2 used as check. Late blight severity observed far below its damaging level. This could be due to absence of environment conducive for *Phytophthora infestans*. Only Janakdev and MS42.3 infected with late blight. Highest yield was obtained from LBr 40 (44.91 t/ha) (Table 7.8)

Table 7.8: Performance of potato genotypes against late blight and yield under farmers filed conditions at Kaski, 2069/70

Genotypes	Late blight (Severity %)	Plant height (cm)	Main stem/plant (No.)	Yield (t/ha)
PRP266264.1	0.00	42	4	40.65
PRP85861.8	0.00	44	3	35.36
CIP389746.2	0.00	48	3	46.00
LBr 40	0.00	45	3	44.91
PRP276264.1	0.00	33	3	33.89
L235.4	0.00	31	3	16.34
Janakdev	10.00	45	4	23.57
MS42.3	20.00	35	3	20.17
F- test	**	NS	NS	**
CV %	81.65	17.13	36.39	32.68
LSD (0.05)	5.362	-	-	18.76

3.1.7.2 Wart

3.1.7.2.1 Screening under laboratory conditions

Wart is an important and serious disease of potato particularly in high altitudes above 2000 masl in Nepal. Potato wart is known by various names, including black scab, black wart, cauliflower disease, potato tumor, potato cancer, potato canker, wart, warty disease, and certainly many other descriptive names in several

languages. This disease is characterized by warty structures on tuber surface emerging from eyes or on stolons but not on roots. Twenty five potato clones were screened against wart disease in controlled conditions at Khumaltar. Trays were filled with sterilized sand and tubers were planted. The trays were kept in seed germinator at 15^0 C and 90 % RH. Since, experiment was carried out in small trays, stolons developed above soil surface and wart symptoms on aboveground parts are hardly noticeable. Further experiment needs to be carried with better conducive environment for conclusive results.

3.1.7.2.2 Screening under pot culture high hills conditions

An experiment was carried out at Nucleus Seed Potato Center, Nigale, Sindhupalchowk (2450 masl) field conditions. Twenty six potato genotypes along with check cultivars Rosita, Janakdev and Kufri Jyoti were evaluated. The experiment was carried out with three replications in 8 inch diameter plastic pots.

The pots were filled with infected soil from previous year. The seed tubers infested with 10 ml suspension (2×10^3 resting spore / ml) in the plastic planters before planting. In order to avoid dispersal of inoculum, the plastic planters were kept on polyethylene sheets. The experiment was carried out at the lower side of the field to prevent further spread of the disease.

Out of the tested genotypes PRP25861.1 produced highest numbers of tubers and lowest numbers of tubers were produced by CIP389746.2 and CIP393280.57 (1). Highest yield in gram was produced by CIP392661.18 (63 gm) and lowest by CIP393280.57 (10 gm). Highest disease index was calculated from Rosita (local check) 93 % followed by L235.4 (83%), CIP392657.8 (72%), PRP25861.11 (71%), CIP385499.11 (66%) and PRP25861.10 (64%). Commercial varieties Janakdev and Kufri Jyoti observed free from wart. Disease was also absent in BSUPO3, PRP35861.2 and CIP392661.18 (Table 7.9)

Table 7.9: Performance of potato genotypes against wart at Nigale, Sindhupalchowk pot culture open air conditions, 2069/70

Genotypes	Infected tuber (No)	Healthy tubers (No)	Incidence (%)	Total tuber (No)	Total yield (g/pot)
CIP389746.2	11.33	5.00	16.33	16.33	0.33
CIP388580.6	4.00	16.00	20.00	20.00	0.67
PRP266264.01	2.67	26.67	29.33	29.33	0.67
Janakdev	0.00	40.67	40.67	40.67	0.00
PRP25861.10	29.33	16.00	45.33	45.33	2.00
CIP-393077.54	4.00	37.33	41.33	41.33	0.33
PRP225861.2	2.67	42.67	45.33	45.33	0.67
PRP25861.11	49.33	8.00	57.33	57.33	5.33
CIP393280.57	4.67	5.33	10.00	10.00	0.33
PRP85861.11	18.00	35.33	53.33	53.33	1.00
Rosita (Check)	47.33	7.33	54.67	54.67	3.67
CIP385499.11	37.33	9.33	46.67	46.67	2.00
PRP85861.12	5.33	40.00	45.33	45.33	0.33
PRP276264.01	2.67	44.67	47.33	47.33	0.67
CIP384321.15	4.67	34.67	39.33	39.33	1.00
PRP25861.1	5.33	33.33	38.67	38.67	0.67
CIP393385.39	7.33	24.67	32.00	32.00	1.33
BSUPO3	0.00	38.67	38.67	38.67	0.00
PRP85861.8	1.33	30.67	32.00	32.00	0.33
CIP392657.8	37.33	6.67	44.00	44.00	2.00
Kufri Jyoti	0.00	56.67	56.67	56.67	0.00
PRP266264.15	2.67	28.67	31.33	31.33	0.33
PRP35861.2	0.00	30.67	30.67	30.67	0.00
CIP394050.110	6.00	40.67	46.67	46.67	1.00
CIP392661.18	0.00	63.33	63.33	63.33	0.00
L235.4	16.33	0.67	17.00	17.00	2.00
F- test	**	**	**	NS	NS
CV%	78.55	53.84	71.68	50.40	56.58
LSD (0.05)	1.99	2.82	50.03	-	-

3.1.7.3 Powdery scab disease management

Replicated experiment was carried out during autumn season of 2069 in Sharadanagar VDC of Chitwan to identify suitable chemical treatment for powdery

scab disease management. This disease is becoming problematic in recent days at inner terai and mid hill conditions.

The experiment was laid out in randomized complete block design with three replications. Potato genotype PRP35861.2 was used in the experiment. Five different chemicals, viz. Antracol (propineb 70% WP), Derosal (Carbendazim 50% WP), Polyram (Metiram 70% WP) and Uthan M- 45 (Mancozeb 75% WP) and bleaching powder were evaluated for their efficacy against powdery scab. Apparently healthy and infected tubers were used as check.

Treatments

1. Seed treatment with Antracol @ 4% (40g/lit water)
2. Seed treatment with Derosal @ 2% (20g/lit water)
3. Seed treatment with Poliram @ 4% (40g/lit water)
4. Seed treatment with Uthane M45 @ 8% (80g/lit water)
5. Seed treatment with bleaching powder @ 2% + soil treatment @ 25 kg/ha
6. Healthy check (Without fungicide)
7. Infected check (Without fungicide)

Infected seed tubers were dipped into fungicide water suspension for half an hour, excess suspension drained out and treated tubers were shade dried. Furthermore, remaining solution used for soil drenching in furrow of respective treatment plots before planting. Compost@ 20 t/ha and chemical fertilizers were applied @ 100: 100: 60 Kg NPK/ha as basal in the furrows opened for planting. Plot size was 2.5 m x 1.8 m adjusting with the planting geometry line to line 60 cm and plant to plant 25 cm. First earthing-up was done at 35 days after planting and flood irrigation was given in furrows. Second earthing up was done at flowering stage and addition irrigation was given at the time of tuber bulking. Only the center row was harvested and data pertaining to total number and yield of tubers, plant emergence, disease index and disease incidence was recorded.

Plant emergence was found non-significant, however scab infected tubers in check plot had lowest emergence as compared to all other treatments. Maximum yield obtained from Uthane M-45 treatments. Lowest yield obtained from scab infected tubers planted plots. Tuber yield were non-significant. Disease index and disease incidence found highly significant between the treatments. Despite of having significant differences in disease incidence, disease index and disease control tuber yield was at par among the treatments (Table 7.10). Disease free tubers fetches good market price, whereas scabbed tubers do not have market value only because of bad appearance.

Table 7.10: Effects of chemical seed treatment against powdery scab under farmer's field conditions at Sharadanagar, Chitwan, 2069/70

Treatments	Disease Index	Disease Incidence (%)	Disease Control (%)	Yield (t/ha)
Antracol	34.74	30.00	62	17.8
Derosal	42.76	59.33	26	14.5
Polyram	45.14	49.67	38	15.8
Uthane M- 45	27.05	25.00	69	20.5
Bleaching Powder	32.45	34.00	57	16.2
Infected tubers	49.3	79.80	0	16.0
Healthy tubers	34.61	35.00	56	19.3
F-test	**	**	-	NS
CV %	12.14	5.44	-	14.33
LSD (0.05)	8.52	4.11	-	

3.2 Sweet Potato

3.2.1 Sweetpotato Variety Improvement

Under sweet potato variety improvement program, NPRP is trying to follow similar varietal evaluation scheme as followed in potato varietal improvement scheme. Collected germplasm are multiplied under *in vitro* and/or screen house conditions, followed by preliminary evaluation in observation trials under field conditions at Khumaltar and/or appropriate locations. The best performing materials are further tested as Initial Evaluation Trial (IET), and later as Coordinated Varietal Trial (CVT) in different collaborative farms and stations. Promising lines from CVT are further promoted to Coordinated Farmers' Field Trial (CFFT) carried out at out-reach research sites of different stations and further one time under farmers' acceptance test (FAT) and the most performing clone are recommended for commercial cultivation in respective locations.

3.2.1.1 Germplasm collection, maintenance and evaluation

Germplasm collection, maintenance and evaluation are major research activities of NPRP. International Potato Centre (CIP), Lima, Peru is one of the major germplasm sources. Till 2011/12, 21 exotic clones received from CIP and six local collections were been maintained under field conditions (Table 8.1). This year (2012/13) additional one exotic genotype, Kentucky Red, and other 15 local genotypes had been collected from different parts of the country, as either stem cuttings or roots (Table 8.1). Altogether 43 different sweet potato genotypes have been planted under field conditions in NPRP, Khumaltar. Out of them, three genotypes (Kentucky Red, Panchkhal Red and Shantipur Red) did not emerge. Collection and maintenance of local as well as exotic germplasm of sweet potato will be continued over times in the programme.

In addition, 25 different sweet potato genotypes had been maintained under field conditions in RARS, Tarahara; ARS, Malepatan and RARS, Nepalgunj.

3.2.1.2 Coordinated varietal trial (CVT)

Introduction

Out of the 21 orange-fleshed sweet potato genotypes under initial evaluation trials in different agro-climatic zones, ten elite genotypes were selected for further evaluation under coordinated varietal trials. During the year 2012/13, one set each of CVT materials were planted at ARS, Pakhribas; RARS, Tarahara; RARS, Parwanipur; ARS (Horticulture), Pokhara; ARS, Surkhet and ARS, Doti.

Table 8.1: List of *in vivo* sweet potato germplasm maintained in NPRP, 2069/70

CIP Number	Code	Variety	Origin	Received Date	Source
400039	CIP-10-01	10-C-1	DOM	Feb. 6, 2010	CIP, Peru
400917	CIP-10-02	Comal	ECU	Feb. 6, 2010	CIP, Peru
440001	CIP-10-03	Resisto	USA	Feb. 6, 2010	CIP, Peru
440007	CIP-10-04	W-208	USA	Feb. 6, 2010	CIP, Peru
440008	CIP-10-05	W-213	USA	Feb. 6, 2010	CIP, Peru
440012	CIP-10-06	W-217	USA	Feb. 6, 2010	CIP, Peru
440014	CIP-10-07	W-219	USA	Feb. 6, 2010	CIP, Peru
440015	CIP-10-08	W-220	USA	Feb. 6, 2010	CIP, Peru
440020	CIP-10-09	W-225	USA	Feb. 6, 2010	CIP, Peru
440021	CIP-10-10	W-226	USA	Feb. 6, 2010	CIP, Peru
440047	CIP-10-11	Bugsbunny	PRI	Feb. 6, 2010	CIP, Peru
440099	CIP-10-12	TIS 9101	NGA	Feb. 6, 2010	CIP, Peru
440112	CIP-10-13	Centennial	USA	Feb. 6, 2010	CIP, Peru
440135	CIP-10-14	Travis	USA	Feb. 6, 2010	CIP, Peru
440185	CIP-10-15	L 0-323	USA	Feb. 6, 2010	CIP, Peru
440267	CIP-10-16	Hung Loc 4	VNM	Feb. 6, 2010	CIP, Peru
440287	CIP-10-17	VSP 3	PHL	Feb. 6, 2010	CIP, Peru
440328	CIP-10-18	AVRDC-CN 1840-284	TWN	Feb. 6, 2010	CIP, Peru
440513	CIP-10-19	Koganesengan	JPN	Feb. 6, 2010	CIP, Peru
441538	CIP-10-20	Tenian	USA	Feb. 6, 2010	CIP, Peru
441624	CIP-10-21	L 4-13	USA	Feb. 6, 2010	CIP, Peru
Japanese Red	HRD-10-01	-	JPN	2010	HRD, Nepal
Dhankuta Red-1	KCU-10-01	-	Dhankuta	2010	Farmer
Dhankuta Red-2	KCU-10-02	-	Dhankuta	2010	Farmer
Sunsari Red-1	KCU-10-03	-	Sunsari	2010	Farmer
Helen	BMS-12-01	-	-	June 2012	Helen Keller
Bengali Red	KCU-12-01	-	India	June 2012	Market
Sangachowk White	KCU-12-02	-	Sindhupalchowk	Nov. 22, 2012	Market
Panchkhal Red	BMS-12-02	-	Sindhupalchowk	Nov. 22, 2012	Farmer
Lamatar White	TPG-12-01	-	Lalitpur	Nov. 22, 2012	Farmer
Batakeshwor White	DC-12-01	-	Dhanusa	Dec. 13, 2012	Farmer
Shantipur Red	DC-12-02	-	Dhanusa	Dec. 13, 2012	Farmer
Barhathwa White	KCU-12-03	-	Sarlahi	Dec. 14, 2012	Farmer
Hansposa White	KCU-13-01	-	Sunsari	Jan. 19, 2013	Farmer
Kentucky Red	NSC-13-01	-	-	Feb. 12, 2013	Nigale
Haibung White	BMS-13-01	-	Sindhupalchowk	Mar. 18, 2013	Farmer
Haibung Red	BMS-13-02	-	Sindhupalchowk	M ar. 18, 2013	Farmer
Fendikuna White	BMS-13-03	-	Lamjung	Jul. 5, 2013	Farmer
Tarkutar White	BMS-13-04	-	Lamjung	Jul. 5, 2013	Farmer
Paundi White	BMS-13-05	-	Lamjung	Jul. 5, 2013	Farmer
Majhigaun White	BMS-13-06	-	Lamjung	Jul. 5, 2013	Farmer
Bensisahar White	BMS-13-07	-	Lamjung	Jul. 5, 2013	DADO
Chipleti White	BMS-13-08	-	Lamjung	Jul. 5, 2013	Farmer

Materials and Methods

Ten outstanding orange-fleshed sweet potato genotypes, viz. CIP 440015, CIP 440021, CIP 440012, CIP 440185, CIP 400039, CIP 440328, CIP 441624, CIP

440135, CIP 440007 and CIP 440267, along with two check genotypes Japanese Red and Dhankuta Red-1 were further assessed for their vegetative and yield characteristics under CVT. Trials were laid out in RCBD with three replications. The 7.2 m^2 sized plots were fertilized @ 30:30:50 kg NPK together with 20 tons of compost per hectare as basal dose. Two-to-three nodal stem cuttings were planted at 60 x 30 cm row to row and plant to plant spacing.

Observations taken were:

- Per cent ground cover
- Plant type (spreading, compact, semi compact)
- Vine color
- Mature leaf color
- Shape of central leaf lobe
- Petiole pigmentation
- Abaxial leaf vein pigmentation
- Flowering habit (yes/no)
- No. of plants harvested
- Fresh weight of foliage at harvest
- Number and weight of marketable and non-marketable roots (tubers)
- Pest damage
- Rotten and cracked roots
- Overall general evaluation of the harvested roots

Results and Discussion

At ARS (Hort.), Pokhara, the overall plant performances were not good s compared to last year. CIP 440012 yielded the highest (9.36 t/ha) followed by CIP 440267 (5.18 t/ha) (Table 8.2). Other promising clones were CIPs 440185 (4.08 t/ha), 440015 (3.84 t/ha) and 440021 (3.75 t/ha). Roots of almost all clones were damaged moderately to highly by rats.

Plant morphological characteristics of sweet potato clones varied considerably among the CVT lines (Table 8.4).

At RARS, Tarahara, CIP 440012 produced the highest yield (4.6 t/ha) followed by CIP 441624 (3.5 t/ha) and CIP 440328 (3.3 t/ha) (Table 8.3).

In case of RARS, Parwanipur the top five promising lines were CIPs 400039, 440267, 440185, 440328 and 440015 with the average yield ranging from 7.24 to 8.74 t/ha (Table 8.3). However, there was no significant difference among the evaluated clones.

Due to very low rainfall along with irrigation problems, the CVT in ARS, Doti failed, as plantation could not be established; in ARS, Pakhribas the plantation had all been destroyed by monkeys just before harvesting.

Table 8.2: Yield of sweet potato clones under Coordinated Varietal Trial (CVT) at ARS (Horticulture), Malepatan, 2069/70

Clones	Foliage FW (t/ha)	Yield (t/ha)	Pest damage†	General evaluation‡
CIP 400039	3.98	1.09	7.0	1.0
CIP 440007	5.67	2.75	5.7	2.3
CIP 440012	4.81	**9.36**	4.3	6.3
CIP 440015	5.60	**3.84**	5.0	4.0
CIP 440021	2.74	**3.75**	4.7	2.7
CIP 440135	4.36	2.57	5.7	1.7
CIP 440185	2.32	**4.08**	4.7	3.3
CIP 440267	3.14	**5.18**	5.7	4.3
CIP 440328	6.92	2.96	7.0	2.0
CIP 441624	4.34	1.93	5.7	1.0
Japanese Red	9.64	2.50	5.0	1.3
Dhankuta-1	7.38	1.49	4.0	1.0
P		0.0116		
LSD (0.05)		3.647		

†: 0 = No damage, 3 = low damage, 5 = moderately damaged, 7 = highly damagesd, 9 = totally damaged
‡: 1 = very poor, 5 = average, 9 = Excellent

Table 8.3: Yield of sweet potato clones under Coordinated Varietal Trial (CVT) at RARS, Tarahara and RARS, Parwanipur, 2069/70

	Yield (t/ha)	
Clones	RARS, Tarahara	RARS, Parwanipur
CIP 400039	1.3	**8.74**
CIP 440007	2.9	4.31
CIP 440012	**4.6**	5.33
CIP 440015	2.2	**7.24**
CIP 440021	2.9	5.67
CIP 440135	1.0	5.29
CIP 440185	2.1	**8.12**
CIP 440267	0.5	**8.35**
CIP 440328	**3.3**	**7.82**
CIP 441624	**3.5**	3.29
Japanese Red	2.7	3.17
Dhankuta-1	4.4	4.35
P	0.0016	0.7345
LSD (0.05)	1.773	ns

Table 8.4: Plant morphological characteristics of sweet potato clones under Coordinated Varietal Trial (CVT) at ARS (Horticulture), Malepatan, 2069/70

Clones	Ground cover†	Plant type	Vine color	Mature leaf color	Shape of central leaf lobe	Petiole Pigmentation	Abaxial leaf vein pigmentation	Flowe-ring habit
CIP 400039	Medium	Semi-erect	Mostly purple	Green	Toothed	Green	Main rib partially purple	no
CIP 440007	High	Extremely spreading	Green with many purple spots	Slightly purple	Toothed	Green with purple stripes	All veins mostly or totally purple	yes
CIP 440012	Total	Semi-erect	Green	Green	Toothed	Green	Yellow	yes
CIP 440015	High	Semi-erect	Green with few purple spots	Slightly purple	Oblanciolate	Green with purple near leaf	All veins mostly or totally purple	yes
CIP 440021	Medium	Spreading	Green with few purple spots	Green	Semi-elliptic	Green with purple stripes	Main rib partially purple	yes
CIP 440135	Total	Spreading	Mostly purple	Green with purple edge	Toothed	Green with purple stripes	Main rib partially purple	no
CIP 440185	High	Extremely spreading	Mostly dark purple	Green with purple edge	Toothed	Green	Purple spot in the base of main rib	yes
CIP 440267	Total	Spreading	Green with many dark purple spots	Green with purple edge	Toothed	Green with purple spots throughout petiole	All veins mostly or totally purple	no
CIP 440328	High	Semi-erect	Green	Green with purple edge	Semi-elliptic	Green	Yellow	no
CIP 441624	High	Spreading	Green with few purple spots	Green with purple edge	Triangular	Green	Purple spot in the base of main rib	yes
Japanese Red	Total	Extremely spreading	Totally purple	Green with purple edge	Toothed	Green with purple stripes	All veins mostly or totally purple	no
Dhankuta-1		Extremely spreading	Green with few purple spots	Green	Lanceolate	Green with purple at both ends	Main rib partially purple	no

†: Medium (50-74%), high (75-90%), total (>90%)

4. SOURCE SEED POTATO PRODUCTION

4.1. Activities under tissue culture laboratory

Since the establishment of tissue culture laboratory and glasshouse facility in 1989, National Potato Research Program has been producing disease-free pre-basic seed potatoes each year during autumn and spring seasons. For pre-basic seed potato production, disease-free *in vitro* plantlets are produced in the tissue culture laboratory and transplanted under aphid-proof glasshouse and screen house under sterile conditions. Following activities were carried out during 2012/13 (2069/70).

Germplasm maintenance

A total of 58 potato germplasm has been maintained under *in vitro* condition in the laboratory (Annex 4.1, 4.2, 4.3, 4.4). Out of them nine cultivars had been used for PBS production purpose.

Rapid propagation

Virus-free mother plantlets are propagated by subcultures using single nodal cutting technique and grown in a growth chamber under 2000 Lux light intensity, 20±2°C temperatures and 16 hr photoperiod. Depending on the cultivar, a fully grown plantlet is obtained after three to six weeks of culture. Five to ten single nodal segments are harvested from each plantlet in the laminar flow cabinet under sterile condition. This process is continued until sufficient plantlets are produced for transplanting in the glasshouse and screen house. A total of 11,301 *in vitro* plantlets of ten cultivars were supplied to the glasshouse/screenhouse in autumn season (August, 2012) and 2500 *in vitro* plantlets of six cultivars in glasshouse/screen house for spring season (Jan., 2013) (Table 9.1)

4.2. Glasshouse activities for pre-basic seed production

Soil mix preparation

About one month before the initiation of transplanting in each season, the sand soil mixture of each bench in the glasshouse and screen house were mixed thoroughly and drenched uniformly with water until the benches were well drained. The soil surface was then gently raked and partitions of one meter were marked along the benches.

Table 9.1: *In vitro* plantlets produced under laboratory condition for plantation in the glass/screen houses, 2012/13 (2069/70)

Cultivars	Autumn, 2012	Spring, 2013	Total
Cardinal	1660	320	1980
Desiree	1345	580	1925
Janak Dev	2195	380	2575
Kufri Jyoti	2241	-	2241
Khumal Seto -1	1290	-	1290
Khumal Rato -2	500	500	1000
Kufri Sindhuri	-	-	-
Khumal Laxmi	5	-	5
IPY-8	45	420	465
TPS 67	-	-	-
MF II	-	-	-
L-235.4	1830	300	2130
CIP389746.2	190	-	190
Total	11,301	2,500	13,801

Soil sterilization

Formaldehyde solution (1%) was drenched thoroughly over the partitioned area to treat the sand soil mixture thoroughly. Immediately after the chemical application, each bench was covered with polythene sheets. Polythene sheets were removed after one week and the sand soil mixture was turned over several times with the help of clean spades to get rid of the volatile chemical residues, which otherwise are phyto-toxic to *in vitro* plantlets.

Transplanting

In August 2012, a total of 11,301 plantlets of ten cultivars were transplanted in the glasshouse/screenhouse for autumn season for pre-basic seed production. Similarly, 2500 plantlets of six cultivars were transplanted in the glasshouse/screenhouse for spring season pre-basic seed production. The total 13,801 in vitro plantlets were produced during the F.Y. 2012/13 (2069/70) (Table 9.1).

Pre-basic seed production

PBSs were produced during two seasons, the first one during autumn 2012 and the second one during spring 2013. During autumn 2012, total of 53,346 PBS comprising thirteen cultivars were produced in glass/screenhouse. The cultivars were Cardinal, Desiree, Janak Dev, Khumal Seto-1, Kufri Jyoti, Khumal Laxmi, Khumal Rato-2, IPY-8, L-235.4, MS 42.3, TPS-7 and 389746.2. In spring 2013, total 70,549 pre-basic seed potatoes comprising 12 cultivars, viz. Cardinal, Desiree, Janak Dev, Khumal Seto-1, Kufri Jyoti, IPY 8, Khumal Rato, Khumal Laxmi, TPS 67, MF II, 389746.2 and L-235.4 were produced in glass/screen house. So,

altogether 1, 23,895 pre-basic seed potatoes were produced during 2012/13 (2069/70) (Table 9.2).

Table 9.2: PBS production in the glasshouse/screenhouse during 2012/13 (2069/70)

Cultivars	Autumn 2012	Spring 2013	Total
Cardinal	10765	10579	21344
Desiree	10755	7923	18678
Kufri Jyoti	9025	9063	18088
Janak dev	10695	12385	23080
Kufri Sinduri	182	-	182
Khumal Seto-1	3367	9969	13336
Khumal Laxmi	60	70	130
I.P.Y8	277	7253	7530
Khumal Rato-2	1083	5272	6355
TPS 67	-	632	632
MF II	-	725	725
L-235.4	6148	5812	11960
MS 42.3	337	-	337
TPS 7	155	-	155
389746.2	497	866	1363
Sub total	**53,346**	**70,549**	**1,23,895**

Cold storage

PBSs were graded into five categories, viz. <0.25 g, <0.5 g, 0.5-1.0 g, 1.0-5.0 g, and >5.0 g size. After grading the PBS were packed in nylon net bags with proper leveling and then stored in Kohinoor Cold store, Balaju. PBS harvested in winter has to be stored for about nine months, whereas those harvested in summer have to be stored for about five months. These pre-basic seeds are distributed to the seed growers and other agencies during the succeeding fiscal year 2013/14 (2070/71). About more 50 per cent of the PBS potatoes produced in autumn 2011 were larger than one gram sized. In case of spring 2012 production, only about 30 per cent tubers were larger than one gram sized (Tables 9.3 and 9.4). In the overall production of 58,732 pre-basic seed potatoes this year, about 60% were larger than one gram sized and about 19% were smaller than 0.5 g sized (Table 9.5)

Table 9.3: Pre-basic seed produced during Autumn (August - November), 2012/13 (2069/70) 1st lot) (To be distributed during terai season, 2012/13 (2069/70)

Cultivars	>5 g	1-5 g	0.5-1 g	<0.5-0.25 g	<0.25 g	Total
Cardinal	5293	2595	1576	796	505	10765
Desiree	4350	2533	2082	1090	700	10755
Janak Dev	3010	3267	2323	1607	488	10695
Khumal Seto-1	1208	928	490	365	376	3367
Kufri Jyoti	5301	2222	831	407	264	9025
IPY-8	165	40	40	17	15	277
TPS 7	91	29	23	12	-	155
MS 42.3	175	73	50	25	14	337
Khumal Rato-2	523	360	100	65	35	1083
L235-4	2167	2108	1005	520	348	6148
Khumal Laxmi	36	8	9	7	-	60
CIP389746.2	262	105	65	30	35	497
K.. Sindhuri	92	37	30	13	10	182
Grand Total	**22673**	**14305**	**8624**	**4954**	**2790**	**53,346**
%	42.5	27.2	16.12	8.93	4.45	

Table 9.4: Pre-basic seed produced during Spring (January – May), 2012/13 (2069/70), 2nd lot (To be distributed during hill season)

Cultivars	>5 g	>1-5 g	>0.5-1 g	<0.5-0.25 g	<0.25 g	Total
Cardinal	1412	4072	2712	1500	883	10579
Desiree	977	2400	2531	1075	940	7923
Janak Dev	670	2600	4171	2754	2190	12385
Khumal Seto-1	532	3024	3258	1585	1570	9969
Khumal Rato-2	180	600	1710	1482	1300	5272
Kufri Jyoti	1185	2914	2872	1354	738	9063
IPY-8	499	2266	2583	960	945	7253
TPS 67	75	172	165	100	120	632
MF II	210	175	160	90	90	725
Khumal Laxmi	-	25	25	20	-	70
L235-4	343	1400	1669	1040	1360	5812
CIP389746.2	21	345	365	85	50	866
Grand Total	**6104**	**19993**	**22221**	**12045**	**10186**	**70,549**
%	8.66	28.34	31.50	17.07	14.44	

Table 9.5: Overall pre-basic seed production during 2012/13 (2069/70)

Plant season	PBS size distribution					Total
	> 5 g	1-5 g	0.5-1 g	0.25- 0.5 g	<0.25 g	
Aut. season	22673	14305	8624	4954	2790	53346
Spring season	6104	19993	22221	12045	10186	70549
Grand total	28777	34298	30845	16999	12976	123,895
%	23.2	27.7	24.9	13.7	10.5	100

4.3 Basic seed (BS) production

Total 3028 kg basic seeds of Cardinal, Desiree, Janak Dev, Khumal Rato-2, Khumal Seto-1, Kufri Jyoti, NPI-106, L-235.4, IPY-8 and Khumal Laxmi and CIP 389746.2 have been produced at Hattiban Farm for further seed multiplication for the next year (Table 9.6).

Table 9. 6: Basic seed produced at Hattiban Farm during F.Y. 2012/13 (2069/70)

Variety	BS 1		BS2		BS3		Total		Total (kg)
	bag	kg	bag	kg	bag	kg	bag	kg	
K.Jyoti	4	153	6	-	6	35	16	188	988
Khumal Seto-1	-	18	4	-	2	-	6	18	318
NPI-106	-	-	-	-	2	20	2	20	120
L 235-4	-	40	-	-	5	-	7	40	390
CIP 389746.2	-	-	-	-	-	20	-	20	20
Red Cardinal	-	-	-	-	2	18	2	18	118
Janakdev	3	60	-	-	8	32	11	92	642
IPY 8	-	18	-	-	-	30	-	48	48
Khumal Rato-2	-	20	-	-	-	18	-	38	38
Desiree	-	30	-	-	6	15	6	45	345
K. Laxmi	-			-		1	-	1	1
Total	**7**	**339**	**10**	**-**	**31**	**189**	**50**	**528**	**3028**

Note : 1 bag = 50 kg

4.4 Pricing and Distribution of Pre-basic Seeds

The per unit price of the pre-basic seed potatoes fixed for the fiscal year 2012/13 was Rs. 10.00 for larger than five gram sized minituber, Rs. 8.00 for 1-5 g sized, Rs. 6.00 for 0.5-1 g sized, Rs. 2.00 for 0.25 -0.50 g and Rs. 1.00 for smaller than 0.25 g sized mini tubers (Table 9.7).

In the Fiscal Year 2012/13, total 53,346 pre-basic seeds produced during autumn season and 70,549 PBS produced during spring season were stored in Kohinoor Cold Store, Balaju Industrial Area, Kathmandu for terai season and hill season distribution, respectively. During 2012/13 all PBS produced in 2011/12 were distributed to seed potato growers through District Agriculture Development Offices, Horticulture Farms/Agriculture Research Stations, NGOs and others throughout the country in coordination with the National Potato Development Program, Department of Agriculture, Khumaltar.

Table 9.7: Pre-basic seed potato pricing of the last few years

PBS Grade	Per unit PBS price (Rs.)						
	1996/97 (2053/54)	1997/98 (2054/55)	2000/01 (2057/58)	2008/09 (2065/66)	2009/10 (2066/67)	2010/11 (2067/68)	**2012/13 (2069/70)**
>5 g size	-	-	-	5.00	5.50	6.00	**10.0**
>1 g size	1.00	1.00	1.50	4.60	5.00	5.50	**8.00**
0.5-1 g size	0.25	0.50	0.70	2.00	2.50	3.00	**6.00**
0.25-0.5 g size	0.00	0.00	0.30	0.50	0.75	0.75	**2.00**
<0.25 g size	-	-	0.05	-	0.25	0.25	**1.00**

4.5 Foundation seed production of rice

To improve the soil health of the Hattiban Farm, rice cultivation with flooding was practiced in rotation. This year, two tons of rice foundation seed was produced, from Khumal-4 (Table 9.8).

Table 9.8: Rice foundation seed at Hattiban Farm

Item	Foundation seed (kg)
Khumal-4	1960
Total	1960

5. TECHNOLOGY TRANSFER AND SERVICES

5.1 Training/Workshops

A training course entitled 'Participatory Variety Selection on Potato' was conducted by National Potato Research Program in Nucleus Seed Potato Center during Magh, 23-25, 2069. The objective of this training was to know the participatory evaluation process for the selection of potato varieties. This training was given to potato farmers, extension workers and researchers. This training was undertaken in two times; at planting time (Magh, 23-25, 2069) and at flowering stage (Jestha, 12-13, 2070) (Annex 5.1).

5.2 Services

- Giving orientation classes to the students from various colleges and universities.
- Counseling on laboratory and field techniques to the national and international visitors.
- Distribution of the leaflets/booklets and folders on different areas to the visitors.

5.3 Publications

Overall 4 publications, viz. three leaflets and one booklet had been published by NPRP this year (Annex 5.2).

5.4 Information through media

- Short interviews were given by concerned scientists on potato production constraints and research outputs for solution, late blight management options for controlling disease, and potato production through hydrophonic pros and cons etc. (Annex 5.3).

5.5 Visits

- Several potato farmers, researchers, extensionists and students visited NPRP laboratory and fields in this year. Their major interest was seen on value addition, disease management, tissue culture technology and variety improvement. CTEVT's JTA trainers also visited NPRP and acquainted with potato cultivation (Annex 5.4).

5.6 Fair and Exhibitions

- NPRP participated in several local level and national level agriculture fairs and displayed its specimens.
- NPRP participated in NARC day and presented own specimens.

6. OTHER ACHIEVEMENTS

6.1 Training/Workshop attended

Mr. BP Sharma, Dr BB Khatri, Dr BP Luitel, Mr P Bhattarai, Mr B Rana and Mr D Choudhary had participated potato training entitled ' Participatory Variety Selection on Potato' which was conducted at NSPC, Nigaley, Sindhupalchowk . This training was conducted in two times at NSPC, Nigaley. Dr BB Khatri had participated in the same training in Jumla, which was organized by Li-Bird.

6.2 Paper presented/published

Overall 17 publications of the NPRP scientists had been published this year, viz. one journals, one in training curriculum, and fifteen in Hamro Sampada (Annex 6.1).

6.3 Awards (received by staff/office)

"Best researcher award" awarded by Nepal Agricultural Research Council (NARC) on its NARC Day. The award was with the amount of NRs. 5000.00 and a certificate.

6.4 Academic supervision

Dr. Bhim B. Khatri has been supervising the senior scientists of NARC for their PhD study; 1. Mr. IP Gautam, Senior Scientist, NPRP. Mr. Gautam is doing his PhD at IAAS Rampur Chitwan. 2. Mr. S. Ahamad Khan, Senior Scientist, RARS Nepalgunj. Mr Khan is focusing his research on stress physiology particularly drought tolerant potato genotypes in Nepalgunj.

7. BUDGET AND EXPENDITURE

The approved regular annual budget for the F.Y. 2012/13 was NRs. 15,422,000.00, out of which NRs. 15,074,000.00 was released with overall expenditure of NRs. 12,505,509.89 (Annex 7.1).

During this year, a sum of NRs. 811,493.19 were collected as revenue through source seed potato, research potato, rice seed and others (Annex 7.2). The past budget expenditures had been audited with a beruju of NRs. 660,271.00 (Annex 7.3).

8. KEY PROBLEMS

8.1 Problems Encountered

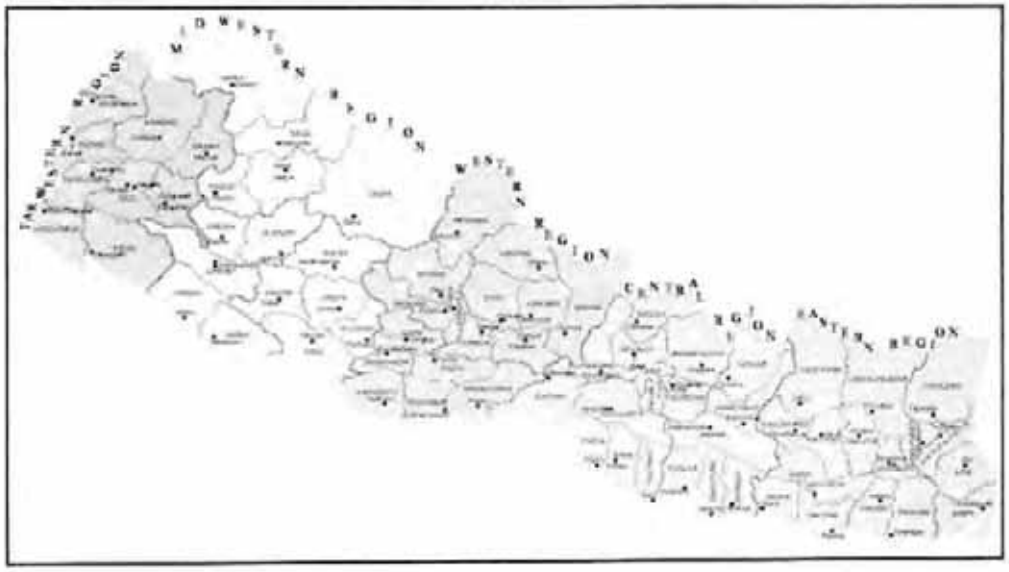
- There was heavy drought in March-April at Hattiban Farm during the tuber formation and bulking stage of potato. Irrigation was limited to all the experiments.
- It was very hard to manage fuel for operating generator to cope with the load shedding.
- As per the agreement, PACT was unable to supply necessary equipments for tissue culture laboratory and glasshouse, which hampered PBS production. Proposed equipments to be supplied by PACT were:
  - Water filtration plant for glasshouse
  - Renovation of incubation room for better electricity supply
  - Bio-safety laminar flow
  - Generator
- It was very hard to carry potato breeding activities, and conduct diseases related research activities without supporting scientists/technicians as well as clean in-vitro materials.
- Insufficient mid-level technical manpower for glasshouse and tissue culture laboratory for PBS production.
- Loss of *in vitro* plants in the tissue culture laboratory due to heavy bacterial and fungal contamination during repairing and construction works of the office building as well as delay in introduction of new potato germplasm have directly affected the PBS production target.
- Lack of cooling facilities in glasshouse
- Poor quality water for irrigation in glasshouse
- No cold storage facilities for storing high quality seed
- Load shedding for longer period 80 hr/week

9. WAY FORWARD

- Variety development (high yielding and tolerant to major biotic and abiotic stresses)
- Development of varieties for processing and value addition
- Utilization of biotechnological methods for crop improvement e.g. molecular characterization, DNA finger printing, somaclonal variation, haploid breeding etc.
- High yielding, early maturing, disease resistant and drought tolerant varieties for high hills,
- High quality nutritious varieties for mid and high hill areas
- Development of late blights resistant varieties as well as management technologies for late blight (disease forecasting etc.) black scurf, powdery scab and wart.
- Red ant management for rainfed hill conditions
- Mechanization for planting, spraying, earthing up, harvesting and grading.
- Low cost quality seed (PBS) production
  - Natural light incubation
  - Hydroponic
  - Aeroponic
- Appropriate storage for seed and processing potato using cold and rustic storage
- Studies on adoption of released varieties and recommended technologies

Annex 1.1

Map of the Command Area



Annex 1.2

Monthly Agro-meteorological Data of the Station/Command Area, 2069/70 (2012/13)

Year	Month	Temperature (°C)		Rainfall mm
		Max.	Min.	
2012	July	28.8	21.3	366.0
2012	August	28.1	20.3	216.0
2012	September	27.9	19.1	199.0
2012	October	26.0	12.0	0.2
2012	November	22.7	5.6	0.8
2012	December	19.7	3.2	0.0
2013	January	18.2	0.9	12.4
2013	February	20.3	5.5	45.1
2013	March	25.1	9.4	32.8
2013	April	28.0	11.7	39.8
2013	May	28.4	16.7	197.0
2013	June	27.9	20.2	242.0

Annex 1.3

Area, Production and Productivity of Potato in Nepal, 2012/13

District	Area (ha)	Production (tonne)	Productivity (kg/ha)
E. Mountain	16,905	235,388	13,924
E. Hills	28,300	352,600	12,459
E. Terai	25,165	290,989	11,563
E. Region	70,370	878,977	12,491
C. Mountain	10,098	126,125	12,490
C. Hills	28,946	464,210	16,037
C. Terai	22,635	356,037	15,729
C. Region	61,679	946,372	15,344
W. Mountain	995	10,094	10,145
W. Hills	14,015	174,574	12,456
W. Terai	7,420	99,851	13,457
W. Region	22,430	284,519	12,685
M.W. Mountain	5,375	54,438	10,128
M.W. Hills	8,604	114,698	13,331
M.W. Terai	8,565	119,880	13,996
MW. Region	22,544	289,016	12,820
F.W. Mountain	2,471	25,947	10,501
F.W. Hills	4,280	64,721	15,122
F.W. Terai	6,476	94,750	14,631
FW. Region	13,227	185,418	14,018
NEPAL	190,250	2,584,302	13,584

Annex 2.1

List of Laboratory Facilities

SN	Name of laboratory	Major instruments	Manpower in laboratory	Facilities
1	Tissue culture laboratory	Autoclave Laminar bench ELISA reader Hot air oven Water bath Distillation units Air conditioners	S-4 = 1 T6 = 1 T-3 = 2 Skilled technician = 1 Labors on daily wage basis = 2	Major six potato viruses (PVA, PVM, PVS, PVX, PVY and PLRV) testing Potato viruses elimination Potato germplasm conservation *In vitro* potato plants production
2	Potato Pathology	BOD Incubator Seed germinator Laminar flow Oven Refrigerator Autoclave Micro digital balance Microscope Stereo microscope	S-4 = 1 T-6 = 1 Labor on daily wages = 1	Pathogen conservation Pathogen storage Pathogen inoculation Disease culture Microscopic observations
3	Post Harvest	Digital balance Frying pan Chip cuter machine	S-4 = 1 T-3 = 1	Dry matter and specific gravity determination, of potato Chip making
4	Potato breeding/Plant Physiology	Refrigerator Microscope Specific gravity measuring instrument	S-4 = 1 S-1 = 1 T-6 = 1 T-3 = 1	Specific gravity Microscopic observations

Annex 2.2

Human Resource in 2069/70 (2012/13)

S.N.	Name	Position	Qualification	Specialization/ Working area	Remarks
1	Mr. Buddhi P. Sharma	S-4	M.Sc.Ag. (Pathology)	Potato pathology	Coordinator
2	Mr. Ishwori Pd. Gautam	S-4	M.Sc.Ag. (Hort.)	Post harvest	
3	Dr. Ram C. Adhikari	S-4	Ph. D. (Hort.)	TPS technology	Transferred to RARS Lumle
4	Dr. Shambhu Prasad Dhital	S-4	Ph.D. (Hort.)	Seed potato/tissue culture	
5	Mr. Binesh Man Sakha	S-4	M.Sc.Ag. (Veg. Crops)	Sweet potato	
6	Dr. Bhim Bahadur Khatri	S-4	Ph. D. (Hort.)	Varietal evaluation/Potato physiology	
7	Dr. Binod Prasad Luintel	S-1	Ph. D. (Hort.)	Varietal evaluation/Potato breeding	On study leave until Bhadra 20
8	Mr. Kaliku Pd. Upadhyay	T-7	M.Sc.Ag. (Hort.)	Organic potato	On study leave
9	Mr. Prakash Bhattarai	T-6	M.Sc.Ag.	TPS	On study leave until Shrawan
10.	Mr. Birendra B. Rana	T-6	B. Sc. Ag	Pathology	
11	Mr. Hari Bdr. KC	T-6	SLC	Pathology	Transferred to Ento. Div.
12	Mr. Krishna Cdr. Upreti	T-6	SLC	TPS & Sweet potato	On deputation from ARS, Pakhribas
13	Mr. Duryodhan Chaudhary	T-6	I.Sc.Ag.	Hattiban Farm	
14	Mr. Sitaram Ojha	A-6	B.A.	Administration	Transfer
15	Mrs. Sumanna Shrestha	A-5	B.Com.	Finance	Transfer
16	Mrs Devi Kumari Dhakal	A-6	B.A.	Administration	
17.	Mr. Prakash Shrestha	A-6	B. Com	Finance	
18	Mrs. Anjali Bajracharya	A-5	B.Com.	Administration	On deputation from RARS, Tarahara
19	Mr. Sanubhai Kuwar	T-5	Test Pass	Glasshouse	Retired
20	Mrs. Bhawani Thapaliya	TH-3	I.A.	Tissue culture lab.	
21	Mr. Ramesh C. Khatiwada	TH-3	7 Class	Coldstore	
22	Mr. Yadav Kr. Shrestha	TH-3	I.A.	Hattiban	
23	Mr. Tej Prasad Ghimire	TH-3	S.L.C.	Glasshouse	
24	Mr. Pancha Maharjan	TH-3	8 Class	Driving	
25	Mr. Bidur KC	TH-3	8 class	Glasshouse	
26	Mrs. Sharada Thapamagar	TH-3	7 Class	Tissue culture lab.	
27	Mr. Shiva Bdr. Sapkota	AH-3	Literate	Khumaltar	
28	Mr. Bidur Pokharel	AH-3	Literate	Glasshouse	
29	Mr. Shyam Bdr. Bhlon	AH-3	I.A.	Administration	

Annex 3.1

Summary Progress of NPRP Research Projects and Activities in 2069/70 (2012/13)

Project code: 40457003 Project end year: Core project

Project title: Variety improvement on potato for different agro-ecologies of Nepal

Project leader: BB Khatri Budget for this FY: 640,000

Project activity #	Name of project/Activity	Activity leader	Major accomplishments
1	Clone multiplication	BB Khatri	This activity is continued at ARS (Hort.) Pokhara & NPRP Khumaltar.
2	Breeding of potato at NPRP Khumaltar	BP Luitel	Hybridization work on potato is continued. The new progenitors are included at crossing.
3	Initial Evaluation Trial (IET)	BP Luitel	IETs are continued at NPRP Khumaltar, ARS (Hort.) Pokhara and ARS (Hort.) Jumla. The clones found promising for 2 years are promoted to CVTs.
4	Coordinated Varietal Trial (CVT)	BP Luitel	CVTs are continued in different locations. The clones found promising in CVTs are promoted to CFFTs
5	Coordinated Farmers Field Trial (CFFT)	BP Luitel	Most promising clones are tested in farmers' fields in various places throughout the country. Most promising and preferred two clones are proposed for releasing.

Project code: 40454002 Project end year: Core project

Project title: Evaluation of true potato seed (TPS) families in the nursery beds and field conditions

Project leader: Prakash Bhattarai Budget for this FY: 177,000.00

Activity code number	Name of activity	End year	Major progress/ achievements
1	Evaluation of TPS F_1C_2 tuberlets production in the farmers field	2069 /70	TPS family HPS7/67 produced the maximum numbers of tubers (429) per plot and LT 8×TPS-67 produced highest tuber yield 15.37 kg/plot of 7.2 m^2 in Sharadhanager VDC of Chitwan district. In Kusadevi VDC, Kavrepalanchok, the highest (22.67kg) tuber weight per plot was obtained in LT 8×TPS-13 followed by LT 8×TPS-67 (22.10kg).
2	Evaluation of F_1C_1 tuberlets of TPS for potato production	2069 /70	Maximum tuber per plot (581.0) was recorded in genotype LT 8×TPS-67

Project code: Special Project end year: 2070/71

Project title:
Project leader: BB Khatri Budget for this FY:

Activity code number	Name of activity	End year	Major progress/ achievements
	Innovative community based agricultural development initiatives for increased climate resilience of people	2070 /71	Germplasm collection, maintenance and multiplication activity was undertaken at ARS (Hort.) Pokhara and at Hattiban Research Farm Khumaltar. At Belachapi, the highest yield was obtained highest (20.1 t/ha) from the clone L 235-4. At Parwanipur Bara, the highest tuber yield was obtained from the clone PRP 35861.18 (20.9 t/ha). In Bhairahawa, the highest yield was obtained from the clone PRP 85861.11 (17.7 t/ha). In Lumle, the highest yield was obtained from the clone PRP 85861.11 (17.7 t/ha). In Jumla, variety Kufri Jyoti gave the highest tuber yield tons per hectare (20.2 t/ha) followed by the clone CIP 385499.11 (18.4 t/ha).

Project code: 40463001 Project end year: Core project

Project title: Study on variety improvement of potato for processing

Project leader: I.P Gautam Budget for this FY: 226,000

Project activity #	Name of activity	End year	Major progress/achievements
1	Evaluation of potato cultivars for yield and processing qualities.	2015	Potato genotypes PRP 25861.1, Khumal Seto-1 and L 235.4 were promising for processing in to chips in Kathmandu valley and similar agro-ecological conditions
2	Evaluation of storability of potato in ordinary condition and cold store	2015	Genotypes Yagana and L-235.4, K. Jyoti and Khumal Seto-1 could be successfully stored in ambient room temperature for maximum period of up to 120 days. None of cold stored genotypes were suitable for chips making and up to 8.86 % wt. loss was recorded in genotype K. Chipsona-2 after 120 DOS & 15 days after reconditioning
3	Effect of chemical treatments on storability and post storage behaviours of selected genotypes of potato in ordinary storage.	2015	Potato tubers fumigated two times with CIPC @ 40 ml/ lit methanol/ tons potato (before & 45 days after storage was effective for inhibition of sprouting and reduction of postharvest losses up to 120 days storage in mid and high hills conditions
4	Conduct spacing trail for processing grade tuber production	2015	There was no effect of spacing on processing tubers of potato in Khumaltar & Chitwan conditions in genotype L-235.4. However, total yield was higher at 60x25-30 cm spacing in Chitwan.
5	Verification of promising lines for processing potato production in hill and terai condition	2015	Genotype K. Jyoti and L-235.4 were promising for higher yield during main season in Kathmandu. Chitwan farmers preferred genotype PRP 25861.1 due to its red colour even though statistically same yield in all tested 7 genotypes.

Project code: 40469001 Project end year: Core project

Project title: Sustainability studies for pre-basic Seed (PBS) and basic seed production

Project leader: SP Dhital Budget for this FY: 390,000.00

Project code #	Name of project/activity	End year	Major progress/ achievements
1	Effect of incubation conditions on microtuber production in potato (3)	2069/ 70	Microtuber can be produce efficiently in *in vitro* condition
2	Studies on the use of sugar free MS medium for *in vitro* plantlets production (3)	2069/ 70	Result not satisfactory
3	Use of natural light for the survival and development of *in vitro* plantlets for PBS production (3)	2069/ 70	Natural light can be used for *in vitro* multiplication
4	Comparative study of hydroponic and soil based medium for efficient production of PBS under glasshouse condition (3)	2070/ 71	Work is on progress. PBS produced more than 5 time.
5	Demonstrate performance of different size of PBS for basic seed production (3)	2069/ 70	Seed size may influence the total tuber yield
6	Demonstrate performance of basic seed-1 and farmer's seed for potato production in farmers' field (3)	2069/ 70	Quality seed produced higher yield
7	Conduct farmers' training on production of quality seed of potato (3)	2069/ 70	

Project code: Special Project end year: 2015

Project title: Improving Food Security and Nutrition of Rural People in Nepal and Bhutan

Project leader: BB Khatri Budget for this FY:

Project code #	Name of project/activity	End year	Major progress/ achievements
	Improving food security and nutrition of rural people in Nepal and Bhutan through collaborative potato breeding for high yield stability and micronutrient density (ADA/CIP funded 3 years' project)	2071 /72	Training on 'Participatory Variety Selection (PVS) on Potato at planting and flowering stage to the NARC researchers, DOA externsionists and potato farmers accomplished at Nigale, Sindhupalchowk CIP395112.32 found high yielding variety at Mother and Baby trial at Sindhupalchowk and Dolakha.

Project code: 404 67 002 Project end year: 2070/71

Project title: Studies on management of late blight, wart and powdery Scab disease of potato

Project leader: BP Sharma Budget for this FY: 295,000.00

Project Activity #	Name of project/activity	Major progress/ achievements
1	Quantification of resistance to *P. infestans* in released and promising varieties in three ecological regions (trai, hills and mountains)	Potato clones resistant to late blight across the locations identified
2	Characterization of of *P. infestans* isolates collected from central region of Nepal	Of the 89 Isolates collected from three ecological regions categorized into A1 and A2 mating types and metalaxyl sensitivity.
3	Selection of environment friendly and cost effective fungicide (s) for late blight management.	Dimethomorph (Acrobat) and Sectin were found to be effective in controlling l late blight with optimum
4	Wart disease screening	Wart resistant potato clones identified
5	Powdery scab disease management	Powdery scab management technology developed
6	Verification of disease resistance clones against late blight under farmers' field.	Clones found resistant under farmers' field conditions

Project code: 40466001 Project end year: Core project

Project title: Sweet potato variety development for food and nutrition security

Project leader: BM Sakha Budget for this FY: 350,000.00

Project activity	Name of project/activity	Major progress/ achievements
1	Collection of sweetpotato genotypes from different parts of the country and abroad	21 orange-fleshed sweet potato clones from CIP and 19 local germplasm from different parts of the country were collected and maintained under *in vivo* condition at NPRP, Khumaltar.
2	Coordinated Varietal Trial (CVT)	At ARS (Horticulture), Pokhara, CIP 440012, CIP 440267, CIP 440185, CIP 440015 and CIP 440021 are promising. In RARS, Tarahara, CIP clones of 440012, 441624 and CIP 440328 were found to be promising. RARS, Parwanipur, CIP clones 400039, 440267, 440185, 440328 and 440015 produced the highest yield ranging from 7.24 to 8.74 t/ha.

Project code: 40455002 Project end year: Core project

Project title: Pre-basic and source seed production of potato

Project leader: SP Dhital Budget for this FY: 1068000.00

Project activity	Name of project/activity	Major progress/ achievements
1	PBS production through tissue culture technology (3)	1,23,895 (no.)
2	Basic seed production (3)	3028 (kg)
3	Germplasm maintenance under *in vitro* condition (3)	58
4	Soil fertility management at NPRP, Hattiban Farm (3)	1960 (kg)

Annex 4.1

List of potato germplasm introduced and maintained at NPRP's Tissue Culture Laboratory during 2012/13 (2069/70)

S.N.	CIP Number	Clones	Received date	Form	Source
1	381379.9	Kisoro	June 6, 2012	In-vitro	CIP, Peru
2	391011.17	B3C1	June 6, 2012	In-vitro	CIP, Peru
3	392740.4	-	June 6, 2012	In-vitro	CIP, Peru
4	393536.13	-	June 6, 2012	In-vitro	CIP, Peru
5	394611.112	-	June 6, 2012	In-vitro	CIP, Peru
6	395017.229	B3C2	June 6, 2012	In-vitro	CIP, Peru
7	395017.242	B3C2	June 6, 2012	In-vitro	CIP, Peru
8	395112.32	B3C2	June 6, 2012	In-vitro	CIP, Peru
9	396287.5	-	June 6, 2012	In-vitro	CIP, Peru
10	391930.1		June 6, 2012		

Annex 4.2

List of potato germplasms maintained at NPRP, Tissue Culture Laboratory during F.Y. 2012/13 (2069/70)

S.N.	CIP Number	Origin	Clones	Received Date	Source
1	800258	India	Kufri Jyoti		CIP, Peru
2	-	-	Cardinal	Nov. 26, 2004	SASA, UK
3	800048	-	Desiree	Oct. 27, 2004	CIP, Peru
4	720123	-	Janak Dev	Feb. 12,1998	CIP, Peru
5	800265	India	Kufri Sindhuri	Mar. 28, 1990	CIP, Peru
6	388572.4	-	IPY-8	-	Cleaned in NPR
7	388572.1	-	Khumal Laxmi	-	Cleaned in NPRP
8	676008	-	Khumal Rato-2	Feb.12,1998	CIP, Peru
9	720088	-	Khumal Seto-1	Feb.12,1998	CIP, Peru
10	-	-	L-235.4	-	CIP, Peru

Annex 4.3

List of potato germplasm introduced at NPRP's Tissue Culture Laboratory during 2012/13 (2069/70) as the first lot

S. N.	CIP Number	*Clones*	*Pedigree*		*Form*	*Source*
			Female	*Male*		
1.	303381.106		388611.22	676008=(I-1039)	In-vitro	CIP, Peru
2.	304369.22		Maricla	676008=(I-1039)	In-vitro	CIP, Peru
3.	304387.92		Reinhort	92.187	In-vitro	CIP, Peru
4.	304394.56		Shepody	391207=(LR93.050)	In-vitro	CIP, Peru
5.	391002.6		386209.1	386206.4	In-vitro	CIP, Peru
6.	391011.17		387041.12	386206.4	In-vitro	CIP, Peru
7.	391046.14		386209.1	387338.3	In-vitro	CIP, Peru
8.	392633.54		387132.2	387334.5	In-vitro	CIP, Peru
9.	392637.10		387143.22	387170.9	In-vitro	CIP, Peru
10.	393371.159		387170.16	389746.2	In-vitro	CIP, Peru
11.	393371.164		387170.16	389746.2	In-vitro	CIP, Peru
12.	395109.29		391589.26	393079.4	In-vitro	CIP, Peru
13.	395111.13		391686.5	393079.4	In-vitro	CIP, Peru
14.	396012.266		391004.10	393280.58	In-vitro	CIP, Peru
15.	396033.102		392639.53	393382.64	In-vitro	CIP, Peru

Annex 4.4

List of potato germplasm introduced at NPRP's Tissue Culture Laboratory during 2012/13 (2069/70) as second lot.

S. N.	CIP Number	Clones	Pedigree		Source
			Female	Male	
1.	379706.27	Costanera	377257.1=LT-1	PVX+PVY BULK	CIP, Peru
2.	381381.9	Rukinzo	378493.915	PRECOZ BULK	CIP, Peru
3.	391058.175		387170.16	387338.3	CIP, Peru
4.	391930.1		BWH-87.338	SELF	CIP, Peru
5.	392797.22	UNICA	387521.3	APHRODITE	CIP, Peru
6.	393083.2		387315.27	390357.4	CIP, Peru
7.	393382.44		387205.5	387338.3	CIP, Peru
8.	393536.13		BEROLINA	386287.1=XY.4	CIP, Peru
9.	393613.2		391896.15=DXY.15	391894.7=DXY.7	CIP, Peru
10.	394611.112		780280=PW-88-6203	676008=I-1039	CIP, Peru
11	395017.229		393085.13	392639.8	CIP, Peru
12.	395017.242		393085.13	392639.8	CIP, Peru
13.	395112.32		391686.15	393079.4	CIP, Peru
14.	395445.16		BWH-87.415	391894.7=DXY.7	CIP, Peru
15.	397067.2		390663.8=C91.628	392820.1=C93.154	CIP, Peru
16.	397079.26		386768.10=MARIA	392820.1=C93.154	CIP, Peru
17.	399067.22		395257.2	395271.6	CIP, Peru
18.	399078.11		395266.3=BIC4046.3	395260.8=BIC4040.8	CIP, Peru
19.	399079.22		395274.1	395257.6	CIP, Peru
20.	701165	Calhua Rosada	-	-	CIP, Peru
21.	703287	Azul..	-	-	CIP, Peru
22.	703312	Morada	-	-	CIP, Peru
23.	703825	China Runtush	-	-	CIP, Peru

Annex 4.5

Production of Source Seed in FY 2069/70

SN	Commodity	Variety	Type	Unit	Target quantity	Produced quantity
1	Potato	14 varieties	Pre-basic seed (PBS)	No.	150,000	1,23,895
2	Potato	11 varieties	Basic seed (BS)	kg	3,000	3028
3	Rice	Khumal 4	Foundation	kg	1000	1,960

Annex 4.6

Distribution of Source Seed in FY 2069/70

SN	Commodity	Type	Quantity	Major stakeholder(s)	Distributed districts
1	Potato	PBS	1,23,895	ADO and seed growers, research farm	Different ADOs
2	Potato	Basic	3028	ADO and seed growers, research farm	Different ADOs
3	Rice	Foundation	1,960 (kg)	Local Farmers	Lalitpur

Annex 5.1

Training/Workshop/Seminar Organized in FY 2069/70 (2012/13)

SN	Name of Training/ Workshop/ Seminar	Dura-tion	Target group	Location	No. of participants
1	Participatory Variety Selection on Potato	2069/10/23-2069/10/25	Farmers, extension officer/researcher	Nigaley Farm, Sindhupalchowk	34
2	Participatory Variety Selection on Potato	2070/2/12-2070/2/13	Farmers, extension officer/researcher	Nigaley Farm, Sindhupalchowk	34

Annex 5.2

Publications in FY 2069/70 (2012/13)

SN	Name of publications	Type *	Lan-guage	Authors	No. of copies
1.	आलुबालीमा लाग्ने ढुबुवारोगको पहिचान एवम् व्यवस्थापन प्रविधि	Leaflet	Nepali	श्री बुद्धिप्रकाश शर्मा	1000
2.	Hydrophonic technology for PBS production	Booklet	Nepali	Dr SP Dhital	1000
3.	Improved Potato Cultivation Practice	Leaflet	Nepali	Dr BB Khatri	1000
4.	Chips preparation technology in home scale	Leaflet	Nepali	Mr IP Gautam	1000

**Books, leaflet, brochure, manuals, pamphlets, audio visual etc*

Annex 5.3

Information Disseminated Through Media, 2069/70

SN	Information disseminated/Media coverage	Type*	Name/ Type of media#	Date/Time
1	Potato production constraints and research outputs for solution	Interview	Ujyalo FM Radio	Aug, 2012
2	Late blight management options for controlling disease	Interview	Ujyalo FM Radio	Dec, 2012
3	Potato production through hydroponic pros and cons	Interview	Ujyalo FM Radio	June 2013
4	Chips preparation technology in home scale	Poster presentation	NARC Day	2070-1 -25 to 27
5.	Released potato varieties	Poster presentation	NARC Day	2070-1 -25 to 27

Annex 5.4

Visits of the Office/Station by Farmers, Extension Officials /Technicians, Entrepreneurs, Cooperatives, Farmer Groups, government/NGO/CBO Officials/students, etc.

S.N.	Category	Number	Districts	Area of major interest
1.	CTEVT's JTA trainers (2069-11-10. Feb 21, '13)	20	Nuwakot	Potato cultivation technology
2.	Students (BSc Microbiology, IIIrd Yr; PK Campus; 2069-11-15, Feb. 26, '13)	8	Kathmandu	Tissue culture lab

Annex 6.1

Papers Published in FY 2069/70 (2012/13)

SN	Title of the paper	Authors	Name of proceedings, journals etc.
1	Determination of Resistance to *Phytophthora infestans* on Potato Plants in Field, Laboratory and Greenhouse Conditions.	Sharma, B. P., H. K. Manandhar, G. A. Forbes, S. M. Shrestha and R. B. Thapa	*Journal of Agricultural Science* (2013). 5:148-157
2.	Potato post harvest research: storage and processing	I. P. Gautam	Training curriculum for crop inspectors on seed potato certification in Nepal. MoAC, NPDP, Nepal
3	आलु आहार एक : पोषक तत्व अनेक	बुद्धिप्रकाश शर्मा	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ २०-२४
4	आलुमा लाग्ने महत्वपूर्ण रोगहरु र तिनको व्यवस्थापन	बुद्धिप्रकाश शर्मा	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर पृष्ठ ५४-६६.
5	आलुबाट बन्ने खाद्य परिकारहरु.	बुद्धिप्रकाश शर्मा र यज्ञ प्रसाद गिरी	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर पृष्ठ १११-११८.
6	आलुका तथ्यपरक एवं रोचक प्रसंगहरु	बुद्धिप्रकाश शर्मा	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ १२२-१२३
7	नेपालमा आलुबालीको महत्व र अनुसन्धानका केही महत्वपूर्ण उपलब्धीहरु	डा. भीमबहादुर खत्री र डा. विष्णुकुमार धिताल	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ ११-१५
8	आलुबालीमा जलवायु परिवर्तको प्रभाव : अवसर की चुनौति ?	डा. भीमबहादुर खत्री	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ १६-१९
9	नेपालमा खेती गरिने विभिन्न आलुका जातहरु	डा. भीमबहादुर खत्री	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ ७०-७५
10	तन्तु प्रजनन् प्रविधिबाट रोगरहित पूर्व-मूल बीउ आलु उत्पादन प्रविधि	डा. शम्भुप्रसाद धिताल	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ ३०-३५
11	बीउ आलु उत्पादन र यसको व्यवस्थापन	डा. शम्भुप्रसाद धिताल	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ

			५४-६६
12	प्राङ्गारिक आलुखेती प्रविधि	इश्वरीप्रसाद गौतम	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ २५-२९
13	घरेलु स्तरमा आलु चिप्स बनाउने प्रविधि	इश्वरीप्रसाद गौतम	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ ११९-१२१
14	आलुको ओसार-पसार तथा भण्डारण	इश्वरीप्रसाद गौतम	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ ७७-८२
15	उन्नत आलुखेती प्रविधि	डा. बिनोदप्रसाद लुईटेल	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ ४८-५३
16	बीयाँबाट आलुखेती प्रविधि,	प्रकाश भट्टराई	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ ३७-३९
17	नेपालमा सखरखण्ड खेती प्रविधि तथा जातीय अनुसन्धान	बिनेशमान साखः	हाम्रो सम्पदा, २०६९ वर्ष १२, अंक-७, मंसीर, पृष्ठ १२४-१२७

Annex 7.1

Regular Annual Budget and Expenditure Record of FY 2069/70 (2012/13)

(in NRs.)

Code	Budget Heads	Annual budget	Budget released	Expenses	Balance
40*	**Staff expenses**	**7,514,000.00**	**7,016,000.00**	**6,949,592.46**	**66,407.54**
4000	Staff Basic Salary	6,142,000.00	5,729,114.00	5,671,573.60	57,540.40
4010	Staff Allowance	0.00	0.00	0.00	0.00
4020	Staff Provident Fund	614,000.00	549,223.00	543,055.86	6,167.14
4030	Staff Medical Expenses	0.00	0.00	0.00	0.00
4040	Staff Uniform Expenses	195,000.00	180,000.00	180,000.00	0.00
4050	Staff Dasai Expenses	501,000.00	495,663.00	495,663.00	0.00
4060	Staff Overtime Expenses	0.00	0.00	0.00	0.00
4070	Staff Pension & gratuity	0.00	0.00	0.00	0.00
4080	Insurance Fund	62,000.00	62,000.00	59,300.00	2,700.00
41**	**Operational expenses**	**3,986,000.00**	**4,136,000.00**	**4,134,048.56**	**1,951.44**
4100	Travel Expenses	671,000.00	671,000.00	671,000.00	0.00
4110	Vehicle Fuel & Lubricants Cost	466,000.00	466,000.00	465,999.94	0.06
4120	Wages to Labour Cost	1,610,000.00	1,610,000.00	1,609,156.76	843.24
4130	Lab and Res. Supplies Cost	415,000.00	465,000.00	464,969.49	30.51
4140	Farm Supplies Cost	664,000.00	714,000.00	713,950.24	49.76
4150	Books, Journal & Publications	50,000.00	100,000.00	99,317.00	683.00
4160	Training & Seminar Cost	10,000.00	10,000.00	9,656.00	344.00
4170	Contract & Collaborative Res.	0.00	0.00	0.00	0.00
4180	Farm Management Project Cost	100,000.00	100,000.00	99,999.13	0.87
42**	**Administrative expenses**	**1,305,000.00**	**1,305,000.00**	**1,304,868.87**	**131.13**
4200	Rent, Utilities & Other Expenses	650,000.00	650,000.00	649,940.80	59.20
4210	Communication Expenses	75,000.00	75,000.00	74,999.78	0.22
4220	Repairs & Maintenance Cost	470,000.00	470,000.00	469,984.94	15.06
4230	Station, Printing & Off. Supplies	60,000.00	60,000.00	59,943.35	56.65
4240	Board and Panel Meeting Cost	0.00	0.00	0.00	0.00
4250	Recruitment Expenses	0.00	0.00	0.00	0.00
4260	Contingency Expenses	0.00	0.00	0.00	0.00
4270	Office Furnishing Cost	50,000.00	50,000.00	50,000.00	0.00
4280	Other Admin. Expenditure	0.00	0.00	0.00	0.00
43**	**Capital expenses**	**2,617,000.00**	**2,617,000.00**	**117,000.00**	**2,500,000.00**
4300	Freehold Land Cost	0.00	0.00	0.00	0.00
4310	Land and Land Develop. Cost	0.00	0.00	0.00	0.00
4320	Building & Other Const^n Cost	2,500,000.00	2,500,000.00	0.00	2,500,000.00
4330	Furniture & Fixture Cost	0.00	0.00	0.00	0.00
4340	Machinery Tools & Equip. Cost	0.00	0.00	0.00	0.00
4350	Vehicles Cost	0.00	0.00	0.00	0.00
4360	Computer & Com. Accesso. Cost	67,000.00	67,000.00	67,000.00	0.00
4370	Other Fixed Assets	50,000.00	50,000.00	50,000.00	0.00
	Grand Total	**15,422,000.00**	**15,074,000.00**	**12,505,,509.89**	**2,568,490.11**

Annex 7.2

Revenue Status of FY 2069/70 (2012/13)

(in NRs.)

S.N.	Source	Total	Remarks
A.	RESEARCH		
	1. Seed Potato	56,943.00	
B.	PRODUCTION		
	1. Pre basic potato seed (PBS)	294,695.00	
	2. Basic potato Seed	131,877.00	
	3. Rice seed	127,400.00	
	4. Ware Potato and mixed rice	23,067.19	
	Subtotal	577,039.19	
C.	Others		
	1. Last year credit	166,511.00	
	2. Admin. income	11,000.00	
	3. Others		
	Subtotal	177,511.00	
	Total	**811,493.19**	

Annex 7.3

Beruju Status of FY 2069/70 (2012/13)

(in NRs.)

Beruju	Amount	Remarks
Beruju till last year	660,271.00	
Beruju cleared this F.Y.	0.00	
Remaining Beruju	660,271.00	
Document processed for clearance of Beruju	0.00	

Annex 7.4

Log Frame of National Potato Research Program, Khumaltar, 2012/13

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS (OVI)	MEANS OF VERIFICATION (MOV)	IMPORTANT ASSUMPTION
GOAL: To improve the food security and livelihoods of Nepalese farmers	□ Health and living standard upgraded and measured	Economic status report	Government realizes important role in food security
PURPOSE: To increase the productivity of potato and sweet potato and farmers income	□ Productivity increased by 25% with the adoption of ICM by the end of 2015	Agriculture statistics report from MoAC	All the stake holders of potato production jointly work
OUTPUTS: 1. High yielding and economically important diseases and insect pest resistant potato and sweet potato varieties developed for major agro climatic conditions. 2. Losses caused by diseases and insect pest minimized. 3. Package of practices for higher yield, safe storage & processing technology developed for potato and sweet potato. 4. Appropriate seed production technology developed and high quality potato seed produced. 5. NPRP efficiently managed, National and International linkages strengthened for potato R & D.	1. At least two late blight resistant varieties and two TPS families and one OFSP variety released for commercial production by the end of 2015. 2. Low cost and environment friendly management technology developed for economically important diseases, weeds and insect pests of potato by the end 2015 3. Package of practices developed for conventional and TPS potato production and post harvest losses minimized by 15 percent. 4. Low cost PBS production technology developed and hand over to private sector to fulfill the demand of high quality seeds by 2015. 5. Programme implemented to achieve the expected out puts by strengthening national and international linkages	1. Report of variety release committee 2. PRP Annual reports/ Project completion report 3. PRP Annual reports/ Project completion report 4. PRP Annual reports/ Project completion report 5. Germplasms and Scientist visit exchanged	Resource allocation for potato research improved as per its importance to address the food security climatic and edaphic factors remain congenial.

ACTIVITIES:	Annual Budget for FY 2069/70	Project monitoring and evaluation report	Project leader get empowered to perform their research projects effectively.
1.1 Variety improvement on potato for higher tuber yield 1.2 Sweet potato variety development for food and nutrition security 1.3 Evaluation of TPS families in the nursery beds and field conditions 2.1 Studies on economically important potato diseases (late blight, scab, wart, viruses and bacterial wilt) 2.2 Studies on economically important insect pests (PTM, leaf minor fly, white grub and red ants) 3.1 Soil fertility management 3.2 Studies on minimization of post harvest losses and value addition 3.3 Development of appropriate package of practices for potato and sweet potato as per climatic conditions 4.1 Sustainability studies for pre-basic seed production 4.2 Pre basic and source seed production on potato	Budget Heads — Rs. '000 4000 Staff expenses — 7,514.0 4100 Operational Expenses — 3,986.0 4200 Admin Cost — 1,305.0 4300 Capital Item cost — 2,617.0 Total Rs. — 15,422.0 **Project wise budget for 2068/69** Project # — Rs. '000 40467002 Studies on mgnt of LB, wart ... 295.0 40467001 Coping with climate change 280.0 40466001 Sweet potato variety develop. 350.0 40463001 Variety imp. for processing 226.0 40457003 Variety improvement 640.0 40457002 Sustain. studies on PBS prod. 390.0 40455002 PBS & source.seed prod. 1068.0 40454002 Evaluation of TPS 177.0 40400001 FMP 840.0 **Total Operational 3,986.00**		
5.1 Organize national potato working group meetings 5.2 Publication of research findings (Annual reports, booklets, leaflets). 5.3 Technology dissemination through radio, TV and print media. 5.4 Coordinate National and International collaborative research projects.			

सूचना

मिति २०७०/०७/१०

Real Time basis मा रसायनिक मलको मौज्दात र तरकारीहरुको थोक तथा खुद्रा मुल्यको जानकारी लिन सकिने बारे ।

कृषि विकास मन्त्रालयले आधुनिक सूचना प्रविधिको उपयोग गरी देशभर कृषि सामग्री कम्पनी अन्तर्गत डिपोहरुमा भएका मल बिक्री तथा मौज्दात विवरण र विभिन्न कृषि थोक बजारहरुमा कायम भएका तरकारीहरुको थोक तथा खुद्रा मूल्य Real Time basis मा On line मार्फत सम्बन्धित सबैले जानकारी लिन सकिने गरी व्यवस्था मिलाएको छ । मल बिक्रि तथा मौज्दात विवरण हेर्न सर्वसाधरणले aicl.f1soft.com.np मा log on गरी Fertilizer Sale and Stock मा Click गर्नु पर्ने छ भने तरकारीहरुको विभिन्न थोक बजारहरुको तुलनात्मक थोक तथा खुद्रा मुल्य हेर्न agribiz.gov.np नामको Web site मा गई market information of selected whole sale market मा Click गरी आएको डाइलग बक्समा All market-Price को Button मा Click गरे पछि सम्पूर्ण मुल्यहरु हेर्न सकिने छ ।

यस सूचना प्रविधिबाट सम्बन्धित सबैले Real Time basis मा महत्वपूर्ण जानकारी हासिल गर्न सक्ने छन् । मन्त्रालयले अझ यस प्रविधिलाई कृषक मैत्री बनाउन SMS मार्फत पनि जानकारी लिन सकिने गरी व्यवस्था मिलाउन लागिएको व्यहोरा समेत अनुरोध गर्दछु ।

प्रभाकर पाठक
प्रवक्ता

AR-5545-B

नेपाल कृषि अनुसन्धान परिषद
कृषि प्रकाशन तथा अभिलेख पुस्तकालय
खुमलटार, ललितपुर

Group photo of NPRP staff, 2069/70 (2012/13)

Top row left to right: Mr. Buddhi Prakash Sharma, Mr. Ishwori Prasad Gautam, Dr. Shambhu Prasad Dhital, Mr. Binesh Man Sakha, Dr. Bhim Bahadur Khatri;

2nd row left to right: Dr. Binod Prasad Luitel, Mr. Prakash Bhattarai, Mr. Krishna Chandra Upreti, Mr. Duryodhan Chaudhary, Mr. Birendra Bahadur Rana;

3rd row left to right: Mr. Prakash Shrestha, Mrs. Devi Kumari Dhakal, Mrs. Anjali Bajracharya, Mrs. Bhawani Thapaliya, Mr. Ramesh Chandra Khatiwada;

4th row left to right: Mr. Yadav Kumar Shrestha, Mr. Tej Prasad Ghimire, Mr. Bidur KC, Mr. Pancha Maharjan, Mrs. Sharada Thapamagar;

5th row left to right: Mr. Shiva Bahadur Sapkota, Mr. Bidur Pokharel, Mr. Shyam Bahadur Blon.

In vitro screening of *Phytophthora infestans* isolates for metalaxyl sensitivity

In vivo screening of potato genotypes for late blight resistance