Annual Report

2076/77 (2019/2020)

Government of Nepal

Nepal Agricultural Research Council

National Agricultural Research Institute

National Seed Science Technology Research Centre

Khumaltar, Lalitpur, Nepal

2020

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Office building of National Seed Science Technology Research Centre, Khumaltar

FOREWORD

It is my great pleasure to present the annual report 2076/77 of National Seed Science Technology Research Centre (NSSTRC) highlighting the accomplished major activities and their achievements in the fiscal year 2076/77. It is the pioneer seed institution of Nepal started with country's first seed testing laboratory since 1962 at Khumaltar, Lalitpur. It still imparts seed quality testing services to the different seed stakeholders. It is working in collaboration and coordination with research groups, producers, distributing agencies, quality regulators, policy makers and seed users. NSSTRC has been involved in undertaking problem based research on seed quality in a variety of crop species (field crops, horticultural crops, and forage crops) in different aspects viz., seed production, seed morphology, seed physiology, post-harvest handlings, storage and molecular level for diversity analysis. It also provides the technical supports/ services to strength national seed system using the quality seeds produced within and outside NARC.

Qualitative and quantitative characterization to develop descriptors and DNA finger printing of different released and pipeline crop varieties/ genotypes of cereals, pulses, oil seeds etc. for seed variety identification and maintenance breeding. Hybrid seed production of maize and rice using different female to male ratio, technology generation on quality seed production of cereals were studied seed testing (germination, viability, moisture, purity etc) in laboratory during 2076/77. Source seed production by different commodity programs, RARS and ARS were monitored.

I am thankful to all staffs of NSSTRC for their untiring hard works and meticulous efforts to accomplish the research and laboratory works on time. My sincere thank goes to Chief Dr. Tara Bahadur Ghimire (S5) for his dedicated work to complete all the activities of this centre and my special thank goes to Ms. Sangita Kaduwal (S1) for compiling and presenting this report in this form. I would like to express my sincere gratitude to the Executive Director of NARC, Dr. Deepak Bhandari, Director of Crops and Horticulture Research Mr. Hari Krishna Upreti; Director of Planning and Coordination, Dr. Ramchandra Adhikari and Director of Finance Mr. Ram Bahadur KC for their guidance and continuous support. I hope that, achievements of all activities presented in this report will useful to all researchers, extension workers, planners, policy makers, farmers, developmental partners, academicians, NGOs/INGOs, students and other stakeholders. I look forward to receive constructive comments and suggestion regarding this publication will be highly appreciated.

Narayan Bahadur Dhami
Senior Scientist (S-3) and Chief
NSSTRC, NARC, Khumaltar

ABBREVIATIONS & ACRONYMS

ABD	Agriculture Botany Division
AFU	Agriculture and Forestry University
AMSL	Above mean sea level
Bo	Boron
BS	Bikram Sambat, Booting Stage
BS	Booting stage
CBO	Community Based Organization
CBSP	Community Based Seed Production
CDD	Crop Development Directorate
CEAPRED	Center for Environmental and Agricultural Policy Research, Extension and Development
Cm	Centimeter
CMS	Cyto Plasmic Sterility (A)
CS	Certified seed
Cu	Cupper
CV	Coefficient of Variation
DADO	District Agriculture Development Office
DNA	Deoxyribose Nucleic Acid
DoA	Department of Agriculture
DoLS	Depatment of Livestock
DUS	Distinctness, Uniformity and Stability
EC	Electrical Conductivity
Fe	Iron
FS	Foundation seed
FY	Fiscal Year
FYM	Farm yard manure
g/gm	gram
GA	Gibbrelic Acid
Ha	Hectare
HICAST	Himalayan College of Science and Technology
Hrs	Hours
HS	Heading Stage
ISTA	International Seed Testing Association
JTA	Junior Techinical Assistant
KU	Kathmandu University
LSD	Least Significant Difference
MAS	Marker Assisted Selection
Max	Maximum
MC	Moisture content
Mg	milligram

Min	Minimum
mm	millimeter
Mn	Manganese
MoALD	Ministry of Agriculture & Livestock Development
NAgRC	National Agronomy Research Centre
NARC	Nepal Agricultural Research Council
NCBGRC	National Crop Breeding and Genetics Research Centre
NGO	Non-Government Organization
NMRP	National Maize Research Program
NORP	National Oilseed Research Program
NPBGRC	National Plant Breeding and Genetic Research Centre
NR	Nepal Rice
NRRP	National Rice Research Program
NSB	National Seed Board
NSCL	National Seed Company Limited
NSSTRC	National Seed Science Technology Research Centre
NWRP	National Wheat Research Program
PCR	Polymerase Chain Reaction
PIC	Polymorphism Information Content
PICS	Purdue Improved Crop Storage
PMAMP	Prime Minister Agriculture Modernization Project
PPP	Public Privet Partnership
R	Restorer
RARS	Regional Agricultural Research Station
RCBD	Randomized Complete Block Design
SEAN	Seed Entrepreneurs Association Nepal
SQCC	Seed Quality Control Centre
SSR	Simple Sequence Repeat
SSTD	Seed Science & Technology Division
Temp	Temperature
TGW	Thousand Grain Weight
TU	Tribhuwan University
Viz;	Namely
WK	Wheat Khumal
Wt.	Weight
Zn	Zinc
IS	Improved seed
(L.)	Linnaeus
@	At the rate of
^{0}C	Degree Centigrade

संक्षिप्त बार्षिक प्रतिवेदन

यस वार्षिक प्रतिवेदनमा राष्ट्रिय बीउ विज्ञान प्रविधि अनुसन्धान केन्द्रको आ.ब. २०७६/७७ को स्विकृत वार्षिक कार्यक्रम अनुसार उन्मोचन भएका तथा उन्मोचन हुने क्रममा रहेका बालीहरु (धान, गहुं, कोदो र तोरी) को मात्रात्मक तथा गुणात्मक चारित्रिक विवरण तयार गर्ने, धान र मकैको गुणस्तरीय वर्णशंकर बीउ उत्पादन सम्वन्धि प्रविधिको निजी तथा सरकारी निकायको साझेदारीमा कृषकको खेतबारीमा प्रमाणीकरण तथा ठूलो क्षेत्रफलमा प्रर्दशन गर्ने, धान र गंहु बालीको जातिय पहिचान र तिनिहरु बीचको जातिय विविधता पहिचानको लागि डि.एन.ए औंठाछाप तयार गर्ने, गुणस्तरिय बीउ उत्पादन सम्वन्धी प्रविधिको विकास गर्ने, विभिन्न सेवाग्राहीद्धारा र अनुसन्धान केन्द्रबाट पठाईएका बीउको नमूनाहरुको परिक्षण गर्ने सम्वन्धि परियोजनाहरुको क्रियाकलाप संचालन गर्दा प्राप्त प्रतिफलहरु यस प्रतिवेदनमा निम्नानुसार प्रस्तुत गरिएका छन ।

- गहुं बालीमा सुक्ष्म खाद्यतत्वहरु (म्यागनिज, जिंक र बोरोन) छुट्टाछुट्टै को प्रयोग गर्दा प्रत्येक जात बीच बोटको उचाईमा धेरै नै फरक पाईयो । यसै गरी फलाम, म्यागनिज, जिंक, तामा र बोरोनको समिश्रण प्रयोग गर्दा सबैभन्दा कम बाझोपना पाईयो भने यी तत्वहरु प्रयोग नगरिएको प्लटमा सबैभन्दा बढि बाझोपना पाईयो ।

- मकै बालीको विभिन्न अवस्थामा घोगाको उचाई भन्दा तलका पातहरु निकाल्दा उत्पादन, घोगाको लम्बाई र चौडाई, दाना संख्या प्रति घोगा, हार संख्या प्रति घोगा, घोगा संख्या प्रति बोट, १००० दानाको तौलमा खासै भिन्नता पाईएन । तर यो नतिजा सन्तोषजनक नभएकोले पुनः परिक्षण गर्नुपर्ने देखिन्छ । रोपेको ६० दिन पछि घोगा देखि तल ५० प्रतिशत पात निकाल्दा spad reading बढि पाईयो र पात ननिकालेकोमा सबैभन्दा कम पाईयो ।

- धान बालीका सिफारिश उन्मुख ७ वटा उत्कृष्ठ जातहरु (एन.आर.१११११५, एन.आर.१११३९, एन.आर.१०६७६, एन.आर.११०११, एन.आर.१११०५, ०८ फ्यान १० र खुमल ४) को बाहिरी आकृति (मात्रात्मक र गुणात्मक) को चारित्रिक विवरण तयार पारियो ।

- गहुँ बालीका ११ वटा सिफारिश योग्य उत्कृष्ठ जातहरु (डब्लु.के. २२५७, डब्लु.के. २४३०, डब्लु.के. २४३२, डब्लु.के. २५५१, डब्लु.के. २७४८, डब्लु.के.३०२६, डब्लु.के.२६०२, डब्लु.के. २६६९, डब्लु.के. २७७७, डब्लु.के. ३०२५, डब्लु.के.३०२७ र डब्लु.के. १२०४) का बाहिरी आकृति (मात्रात्मक र गुणात्मक) को चारित्रिक विवरण तयार पारियो ।

- कोदो बालीको सिफारिश गरिएका जातहरु (डल्ले कोदो १, ओख्ले कोदो १, काब्रे कोदो १, काब्रे कोदो २, सैलुङ्ग कोदो १, के.एल.ई १५९, के.एल.ई २३६ र के.एल.ई १५८) को बाहिरी आकृति (मात्रात्मक र गुणात्मक) को चारित्रिक विवरण तयार पारियो ।

- तोरी बालीका ४८ वटा जात/लाईनहरु (सिफारिश गरिएका र अन्य) को बाहिरी आकृतिको चारित्रिक विवरण तयार पारियो ।

- धान बालीका ८७ वटा लाईनहरु (सिफारिश गरिएका र अन्य) को बीच विविधता पत्ता लगाउनको लागि १५ वटा एस.एस.आर. प्राईमर मार्कर को प्रयोग गरि डि.एन.ए. औठा छाप तयार गरियो ।

- वर्णशंकर धानको बीउ उत्पादन गर्न भाले पोथी विभिन्न अनुपात (२:६, २:८, २:१० र २:१२) मा लगाउंदा २:६ अनुपातको उत्पादन ३.३० ट/हे, २:८ अनुपातको उत्पादन २.२४ ट/हे, २:१० अनुपातको उत्पादन ३.१६ ट/हे र २:१२ अनुपातको उत्पादन ३.५९ ट/हे पाईयो । तर यो नतिजा सन्तोषजनक नभएकोले पुनः परिक्षण गर्नुपर्ने देखिन्छ ।

- मकै बालीको वर्णशंकर बीउ उत्पादन प्रविधिको प्रमाणिकरण गर्नको लागि भाले पोथीको अनुपात क्रमश १:३, १:४, १:५, २:४, २:५, २:६ र २:८ प्रयोग गरि अध्ययन गरिएको थियो । तर लामो समय सम्मको बन्दा बन्दीको कारणले उत्पादन तथा अन्य आकंडाहरु लिन सकिएन ।

- बीउ परिक्षण सम्वन्धमा २१९ वटा सेवा बीउ नमुनाहरु र २२९ वटा अनुसन्धान बीउका नमूनाहरु गरि जम्मा ४४८ वटा नमुनाहरुको परिक्षण गरियो ।

EXECUTIVE SUMMARY

This is the annual report of National Seed Science Technology Research Centre (NSSTRC), NARC for the fiscal year 2076/77 (2019/2020). There were five research projects on problems related to quality seed production, varietal identification, maintenance breeding and verification of hybrid seed production technology of rice and maize with PPP model. Experiments were carried out in field as well as in the laboratory of NSSTRC, Khumaltar. Major research areas were; seed production, genuineness of crop varieties and their morphology and seed quality enhancement techniques. Crops under study were rice, maize, wheat, finger millet and rapeseed (Tori). The key findings of these research studies are as follows:

- There was a significant difference observed in stage factors, plant height, number of spikelet/spike and sterility percentage in wheat. No significant difference observed among the micronutrients factor except number of spikelet/spike. Significant difference observed in plant height when applied Mn, Zn and Bo seperately. Similarly, significantly high sterility percentage found in control and lowest sterility percentage observed when applied combination of Fe+Mn+Zn+Cu+Bo.
- There was not significant difference of defoliation, stage of defoliation and their interaction effect in phenological traits, stalk yield and grain yield, plant height, cob diameter, cob length, number of grain/cob, number of cob/plant, number of row/cob, final plant stand, barrenness percentage, and TGW (g). Significant difference was observed in SPAD reading at 60 DAS whereas highest SPAD reading was recorded of 50 percent leaf removal below the ear and lowest reading found in control.
- Descriptors of 7 hill genotypes of rice (NR-11115, NR-11139, NR-10676, NR-11011, NR11105, 08 FAN10 and Khumal-4) prepared.
- Descriptors of 12 genotypes of wheat (WK-2257, WK-2430, WK-2432, WK-2551, WK 2748, WK 3026, WK-2602, WK-2669, WK-2777, WK-3025, WK 3027 and WK-1204) prepared.
- Descriptors of 9 varieties/genotypes of finger millet (Dalle 1, Okhle 1, KLE 159, Kabre kodo 1, KLE 236, Sailung kodo 1, KLE 158, Kabre kodo 2) prepared.
- Descriptors of 48 local genotypes including Vikash, Pragati, Lumle Tori, Unnati, Bal tori, Preeti, Surkhet local 3 and Morang tori of rapeseed (toria) prepared.
- DNA finger prints of 87 rice genotypes prepared by using 15 different SSR markers.

- In hybrid rice seed production; results of different male and female ratios of 2:6, 2:8, 2:10, and 2:12 were studied. Result showed that 2:12 ratio (3.59 t/ha) and 2:6 ratio (3.30 t/ha) produced relatively higher grain yield.
- In hybrid maize seed production by using different male/female ratio of 1:3, 1:4, 1:5, 2:4, 2:5, 2:6, 2:8 were studied. Trial was not harvest due to more than one month long lockdown.
- 219 service seed samples and 229 research seed samples were analyzed and reported to the concerned stakeholders.

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1. WORKING CONTEXT

Seed technology is one of the central disciplines in agricultural science which is featured to lead the research and reviews on the problems relating to seed quality, seed physiology, seed production, seed health, harvest, processing, sampling, pre-and post-harvest management. Seed enhancement technology, variety identification, genetic purity evaluation, testing for genuineness of plant variety, development of seed quality assessment procedures, human resource development, and seed quality testing are therefore the research areas of the centre. National Seed Science Technology Reseach Centre (NSSTRC) is the leading centre under National Agricultural Research Institute (NARI) of Nepal Agricultural Research Council (NARC) based in Khumaltar (1335m amsl; 85°10′ E and 27°39′ N). It embark on the research works on these disciplines and provides services ensuring the production and supply of quality seeds to farmers in a right place and time and helps in achieving a good harvest.

In the present context of depleting land and increasing population, we have to produce adequate food to address the hungry mouths. It is the established fact that use of quality seed maintains required plant population and uniform maturity leading to improving yield by 15-20 percent. Basic and applied researches on seed science and technologies relating to seed quality, seed biology, seed management, seed quality enhancement, pre-harvest and post- harvest management, and seed distribution and support in activities related to seed policies and regulations are the areas dealt during the year as core research activities. NSSTRC is the central centre for seed in NARC. Consequently it works in collaboration with different institutions/programs with seed component and involved in improving information about use and supply of quality seeds in the country. Major collaborative institutions are Seed Quality Control Centre (SQCC), Department of Agriculture (DoA), Crop Directorate of Development and Agriculture Biodiversity Conservation Center, National Seed Company Limited (NSCL), SEAN, CEAPRED, private seed companies, universities, seed cooperatives, CBSP groups and farmers.

2. INTRODUCTION

2.1 Introduction and Background

National Seed Science Technology Research Centre (NSSTRC) former Seed Science and Technology Division (SSTD) is the central division re-established on 2068 BS, which works in close collaboration with the crop improvement and agricultural development programs. The centre undertakes the works and responsibility in two ways: (a) adaptive research on seed technology and (b) seed improvement through education, trainings and seed quality testing services.

NSSTRC took its origin as first seed testing laboratory in 1962 in Agronomy Division under the then Department of Agricultural Development (DoAD). It got accredited to the International Seed Testing Association (ISTA) in 1964. In early seventies, the use of improved seeds increased and the seed testing laboratory moved to Agriculture Botany Division (ABD) to work in close with the breeders. Seed Technology and Improvement Program (STIP), Central Seed Science and Technology Division (CSSTD) were the upgraded modalities and given the divisional status in due course with pivotal role bridging between reseach, extensions and end users of seed through seed certification, field inspection, seed testing, seed technology research and planning and monitoring of source seed production. On inception of Nepal Agricultural Research Council (NARC), Seed Research aas a unit merged again in Agriculture Botany Division (ABD) and is entiteled to conduct seed research on practical problems and support in strengthening national seed programs in use and distribution of quality seed. Seed Science and Technology Division (SSTD) as an independent division under NARI has been approved by the 41st NARC Council meeting. It has been effective as central centre of seed in Khumaltar from 2010/11 fiscal year.

The centre has been functioning effectively with fundamental role of bridging between research, extensions and end users of seed through seed monitoring, seed testing, seed technology research and planning and monitoring of source seed production. NSSTRC as a central discipline for seed in NARC is therefore authorized to conduct seed research on practical problems and support in strengthening the national seed programs in use and distribution of quality seed. It, therefore, undertakes research on seed technology in a range of crop species on problems related to production, seed quality parameters, storage, physiology; provides seed quality testing services and monitors the quality of source seed produced in research farms and stations under NARC. The prime aim of the centre in NARC is to assist the use and production of quality seed through research for agricultural development and work on seed in close collaboration and coordination with different seed stakeholders under National seed system.

2.2 Goal

Promote and develop the national seed system through the use of quality seeds

2.3 Objectives

- To carry out the seed technology research on problems associated with quality seed on seed production, harvesting, post-harvest handlings and storage; seed morphology; seed physiology and seed quality testing,
- To develop and standardize seed testing techniques through research support on seed certification system,
- To make the seed producers, farmers, institutions and organizations aware of the value of use of quality seeds of improved crop varieties through training, education, field monitoring and quality testing services,
- To provide venue of dissemination and exchange of information on seed, availability of source seed, seed related technologies among the seed stakeholders,
- To work in close with the stakeholders of seed quality and central seed testing laboratory on regional and national problems on seed through quick researches as and when needed.

2.4 Strategies

During the inception time, NSSTRC focused on development of procedures for testing the quality of seeds and providing quality testing services and quality information of seed lots to the farmers in the country. In due course of time with provided emphasis to strength policies, HYVs of crops introduced, commodity research programs adopted and many international collaborative seed sector development projects implemented and strengthened the seed quality and research program. The program established the seed regulatory instruments to safeguard the use of quality seeds and helped the program in achieving the agricultural goal.

NSSTRC's strategy in present context is to support the national seed program and improve the agricultural production through the intensive use of improved varieties of quality seed and carry out the research on problems related to seed quality, its production and application. Followings are the relative foci and research approaches (in *Current thrust areas for research*) of NSSTRC pursuing the above strategy:

- Strengthening national seed program in use of quality seeds,
- Carrying out the adaptive research on seed quality and use,

- Providing quality testing and information services on use of quality seeds,
- Developing and promoting improved seed technologies,
- Contributing in collaboration with national and international institutes/stakeholders in use of quality seeds.

2.5 Current thrust areas for research

Seed is a living entity. Its quality is affected by different factors at various stages during production, harvesting, processing and post-harvest handlings. Based on changes in planning of agricultural research and priority paid to research on problems demanded by time, space (location specific) and clients (users group), following areas for research have been identified and undertaken the research activities associated with quality traits of seed and develop the appropriate technologies.

2.5.1 Seed production technology

Seed production follows a definite sequence of steps and needs constant surveillances and immediate actions when problems arise. Introduction of new varieties like hybrids, inbreds, forage crop varieties; diverse cropping systems, cultivation of a range of crop species with different biology, changing environmental conditions, natural calamities and incidence of diseases/pests and their threats are the areas of research that may create problems in seed production. In such cases, sudden modifications in production technologies need to be adopted to achieve the quality and quantity harvest. Besides, seed crop physiology, crop husbandry, the biology of seed maturation, role of minerals and micronutrients are the important aspects in seed production which require intensive research for harvest of quality seeds.

2.5.2 Seed testing technology and seed physiology

Seed testing determines the planting value of seed. Seed testing in general is carried following the methods standardized by International Seed Testing Association (ISTA). However, discrepancies in test results do occur in seed testing. In these circumstances, the centre undertakes research and could develop the appropriate testing technology and assists the seed regulation programs with the quality testing techniques and supports in developing the seed and field standards.

2.5.3 Seed morphology and taxonomy

Genetic purity is one of the quality attributes of seed. It is maintained in seed crop by planting in isolation, field inspection in standing crop and by maintaining physical purity and pre-and post-control plot tests in the laboratory. It is necessary to undertake the practical researches and develop the distinguishing and identifying

characters of each named varieties to avoid the genetic contamination in field and seed. The centre, therefore undertakes the genuineness cultivar testing using the conventional field evaluation for agro-morphological characters, biochemical testing and also the molecular testing.

2.5.4 Seed post-harvest, handling and storage technology

Seed as an end product in seed production. It is a living material which deteriorates in storage and finally dies. It requires careful handling, safe processing and storage environment condition. Seed processing, drying, seed moisture level, seed treatment, seed storage containers, storage conditions and mechanism of seed dissemination have great effect on seed viability and longevity. The centre has the facilities in carrying the research on these areas and it has also working experience in collaboration with the national and international seed technology institutions.

2.5.5 Seed variety identification using DNA finger printing technology

DNA finger printing and new advancement in molecular techniques are the tools that its application in crop research (gene mapping, genotyping, MAS), conservation of biodiversity (duplication/redundancy in gene bank, core collection strategies, diversity analysis) and seed varietal identification has helped breeders, curators and seed analysts. With support of donor programs, a set of resources/facility on these modern techniques has been developed in the centre. The centre can use these facilities in developing the DNA finger printings of the crop varieties for release and registration process. SSR based DNA finger printing of rice, wheat, lentil, rape seed genotypes (national listed varieties, landraces and wild types) are being achieved.

2.6 Infrastructure and facilities

The centre has its own two floor office building but top floor is using by National Biotechnology Research Centre at Khumaltar. This centre is equipped with the seed testing/research and molecular laboratories. It is equipped with the seed quality testing facilities and molecular marker testing at DNA level. It provides seed testing services of all kinds of agricultural, horticultural and forage crop species to farmers, seed producers, seed companies, researchers and provides analyzed reports following the rules for testing seeds by ISTA, 2011 and guidelines and norms developed by national seed regulatory body under NSB. Analytical purity test, moisture test, germination test are the general testing services whereas accelerated ageing test of wheat, cold test of maize, tetrazolium test, biochemical test for varietal identification (phenol and potassium iodide-iodine tests) and pre and post field plot tests are the special tests providing by the centre. The centre has strengthened the molecular testing facilities for carrying out the genuineness test of the crop varieties using DNA molecular markers and these

facilities are also used in studying the genetic diversity of agricultural crops specific to landrace diversity. These facilities are listed in annex 4.1 and 4.2.

The centre also provides technical backstopping to SQCC in developing seed testing procedures, seed standards, field standards and minimum quality standards and assists in planning of source seed demand and supply. The centre generates database on seed and seed related other matters and coordinate the NARC seed component among the seed stakeholders.

2.7 Organizational structure and human resource

Following figure explains the organizational structure of NSSTRC. It explains the working modality and human resources strength (HRs) that is adopted to help in achieving the objectives and strategies of the centre. The centre has eleven staffs namely one principal scientist-5, one scientist-1, one technical officer-T6, one administrative officer-A6, Assistant Accountant-A5, three lower technicians-T1 and one light driver. Details of human resource is given in Annex 5.

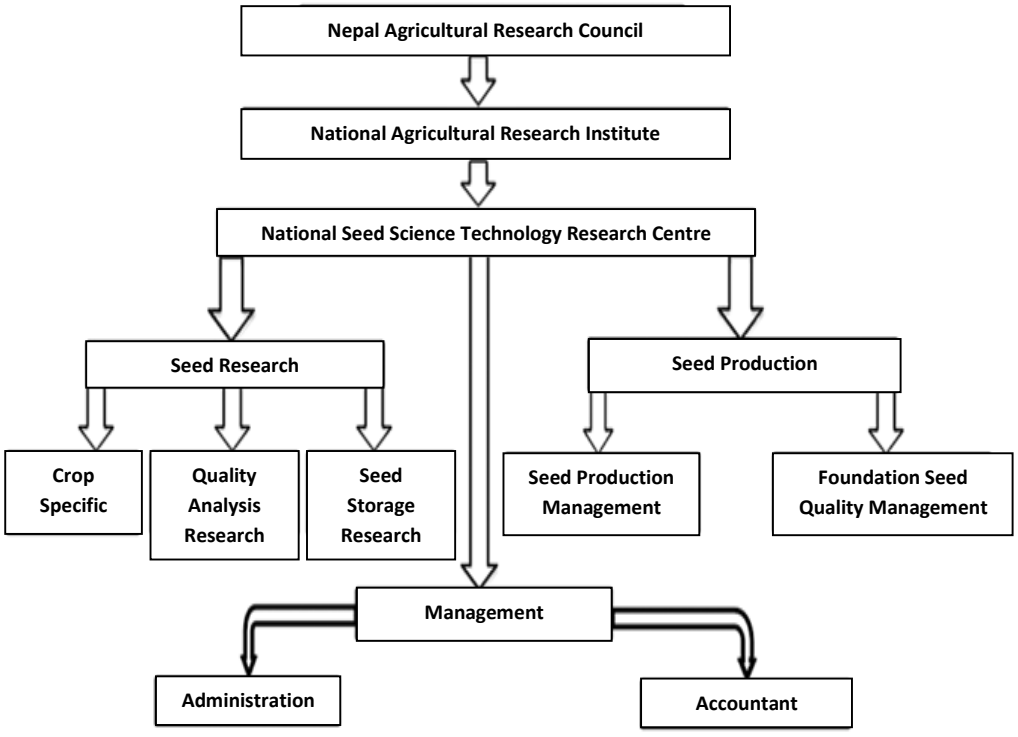


Fig. 1: Organogram of NSSTRC

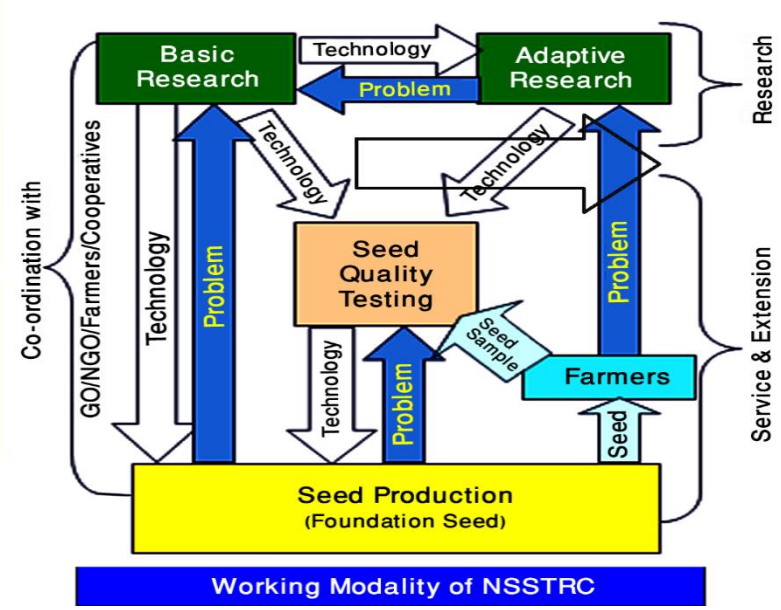


Fig. 2: Working modality, NSSTRC

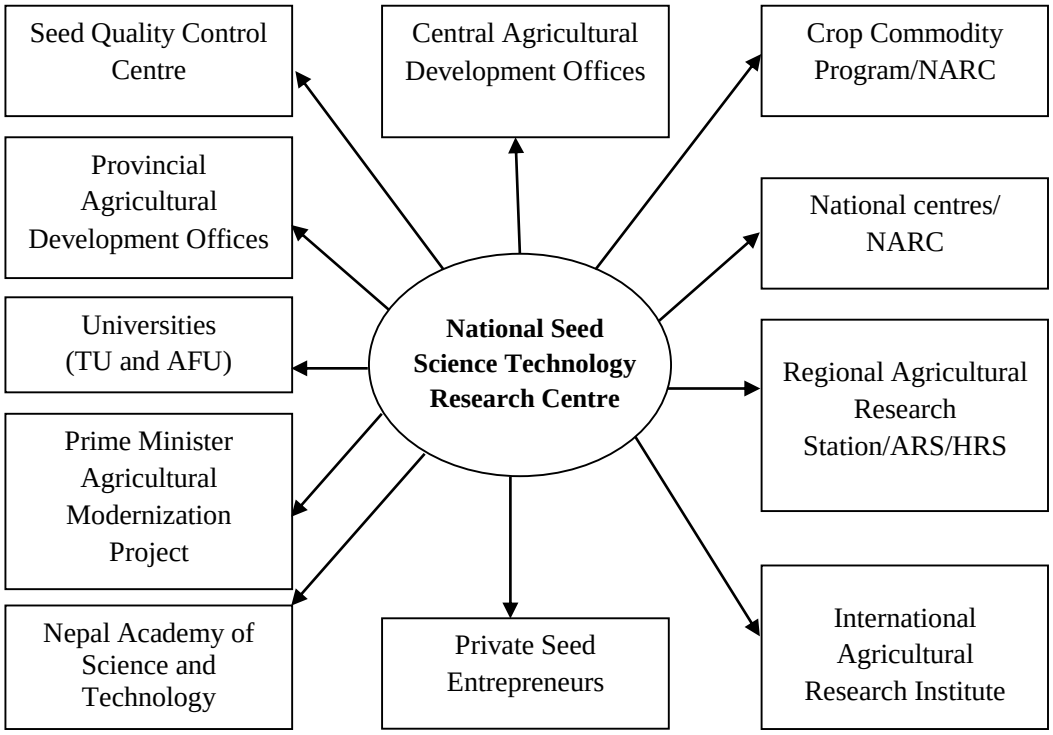


Fig. 3: Linkage and coordination, NSSTRC

3. RESEARCH HIGHLIGHTS

3.1 SEED PRODUCTION TECHNOLOGY

3.1.1 Effect of foliar application of micronutrients on seed quality and productivity of wheat

Introduction

Wheat is a third major food crop next to rice and maize in Nepal. It occupied 703992 ha of land with production and productivity of 2005665mt and 2.84t/ha respectively (MoALD, 2018/2019). It has significant role in the agricultural system of Nepal. Multiple micronutrient deficiencies (Zn, Mn, Fe Cu, B and Mo) have been frequently occur in soil of the Nepal and are becoming more prevalent as cropping intensity increases. However, most of Nepal soil is deficient in these nutrients. Foliar fertilization enhances the availability of nutrients. Micro-nutrients applied through soil are not as effective as when it is supplied to the plant through foliage. It also ensures the ample availability of nutrients to crops for producing higher seed yield. Foliar spray of micronutrients is more effective to control deficiency problem than soil application. Foliar application of B at reproductive stage enhanced seed yield of wheat while its deficiency might cause male sterility resulting in seed set failure in wheat. In Nepal most soil has been suffering from micronutrients deficiency due to intensive cropping system. Day by day, the micronutrients are reducing in soil due to more dependence on synthetic fertilizers and increase in cropping intensity with high nutrient requiring varieties. By the foliar application of micronutrients, its concentration can be increased. Decreased use of organic manure, imbalanced use of macronutrient fertilizers, reduced recycling of crop residues, have led to micronutrient deficiencies. Increase in fertility levels progressively increases the total removal of micronutrients due to increased dry matter production thus reducing productivity and quality of wheat seed.

Objectives:

To improve the seed quality and increase the productivity.

Materials and methods

The experiment was carried out at Khumaltar. Seed was received from NPBGRC. It was conducted in RCBD design with three three replications. It consisted of two different factors i.e. stage factor (booting and heading stage) and micronutrients factor (Fe, Mn, Zn, Cu, Bo). Plot size was of 1.25m*5m with spacing between rows of 25cm and continuous seeding. Seed rate was applied @120 $kgha^{-1}$. Sowing was done on 22nd Nov, 2019. Recommended dose of chemical fertilizer was @120:60:40 Kg NPK ha^{-1}. Half of the recommended dose of N and whole P_2O_5 and K_2O was applied as a basal dose during sowing and remaining half dose of N was again divided into two split doses. First half dose of N was applied at tillering stage and remaining half dose at booting stage.

Irrigation was managed possibly as per requirement from tillering to grain filling stage. Required data were recorded from five randomly selected tagged hills (tillers) from each plot and grain yield recorded from net harvested area of each plot excluding the boarder rows and converted in t/ha. Data were processed and analyzed by using R stat.

Results and Discussion

Results of ANOVA revealed that significant differences (stage factors) observed in plant height, no of spikelet per spike and sterility percent among the genotypes but no any significant differences found in micronutrient factors except number of spikelet per spike. Days to maturity, no of tiller per plant, no of grains per spike, seed length(mm), seed width (mm), seed depth (mm), TGW(g), straw yield (t/ha) and grain yield (t/ha) were observed similar among the genotypes. A significant variation observed in plant height when applied Mn, Zn and Bo and found similar to control. Significantly highest sterility percent found in control and lowest when applied combination of Fe+Mn+Zn+Cu+Bo micronutrients and others were at par to each other. Significantly difference observed in number of spikelet/spike when applied combination of Fe+Mn+Zn+Cu+Bo and Cu micronutrients. Significant interaction effect observed between stage of crop and micronutrients only in number of spikelet per spike. Detail results are presented in table 1.

Table 1: Effect of foliar application of micronutrients on seed quality and productivity of wheat, Khumaltar

Treatments	NT/ plant	SL (cm)	PH (cm)	NS/ spike	St. (%)	NG/ spike	DM (80%)	SL (mm)	SW (mm)	SD (mm)	TGW (g)	SY (t/ha^{-1})	GY (t/ha^{-1})
Fe	10	12.33	102.5	19	5.97	48	137	6.67	3.72	3.06	55.00	7.23	3.84
Mn	10	13.2	104	19	5.49	51	137	6.8	3.72	3.01	48.33	7.34	3.61
Zn	10	12.07	102.1	19	5.72	46	137	6.55	3.69	3.04	46.67	7.02	3.63
Cu	9	11.77	100.1	20	5.06	51	137	6.72	3.62	3.03	46.67	7.59	3.63
Bo	10	12.78	103.7	19	5.35	53	137	6.68	3.69	3.07	48.33	7.57	3.75
Fe+Mn+Zn+Cu+Bo	10	11.77	100	20	4.84	52	137	6.73	3.65	3.01	50.00	6.97	3.85
Control	9	11.33	100.8	18	7.24	51	137	6.55	3.62	2.98	43.33	7.73	3.13
Grand Mean	9.60	12.24	102	19.6	5.54	50	137	6.68	3.68	3.03	48.2	7.32	3.62
Mean: BS	9.40	11.87	100.3	19.1	19.07	6.6	137	6.63	3.64	3	48.09	7.39	3.57
Mean: HS	9.85	12.67	103.9	20.1	20.13	6.8	137	6.75	3.72	3.06	48.33	7.24	3.67
CV (%)	18.05	11.35	3.8	16.8	21.1	2.5	137	2.5	3.86	3.88	23.49	9.65	11.54
LSD(stage factor)	-	-	2.4	-	-	-	-	-	-	-	-	-	-
LSD(micro factor)	-	-	ns	1.7	3.2	-	-	-	-	-	-	-	-
P-value (stage factor)	ns	ns	**	*	***	ns	ns	ns	ns	ns	Ns	ns	ns
P-value (micro factor)	ns	ns	-	-	ns	ns	ns	ns	ns	ns	Ns	ns	ns
P-value interaction	ns	ns	-	*	ns	ns	ns	ns	ns	ns	Ns	ns	-

Note: NT=Number of tiller, SL=Spike length, PH=Plant height, NS=Number of spikelet, St=sterility percent, NG=Number of grains, DH=Days to heading, DM=Days to maturity, SL=Seed length, SW=Seed width, SD=Seed depth, TGW= Thousand grain weight, SY=Straw yield, GY=Grain yield, BS=Booting stage, HS=Heading stage

3.1.2 Effect of defoliation on yield components and grain quality of maize

Introduction

Maize *(Zea maize* L.) is the second most important crop after rice in terms of area and production in Nepal. It covered 956447 ha. of land with production and productivity of 2713635mt and 2.84t/ha respectively (MoALD, 2018/2019). There are many biotic and abiotic problems associated with maize cultivation. Among those, barreness in maize, sterility, low fertilizer use and incorrect timing of fertilization could be the reasons for decreasing maize productivity. Low seed replacement rate and use of poor quality seed at farmers level is a basic problem in maize cultivation. Maize defoliation improves the grain yield through greater functioning of remaining young leaves, enhancing light interception, increasing nutrient uptake efficiency, decreasing competition among the tassels and cobs for available plant nutrients, diverting plant nutrients to the reproductive part which aids in better source-sink relationship and better cob development. It also maximizes the efficiency to distribute the available photosynthetic accumulation within plant from source to sink thus leading to increase seed yield. It involves a low cost and non-monetary input technology. Tassel removal may increase the seed yield and enhance the seed quality. Interaction of defoliation and tassel removal may also affect assimilate distribution between vegetative and reproductive organs. A total of 75% of the plants could be destasseled randomly just before pollen shedding. However in maize research information on this aspect is seldom available.

Objective:

- To study the effect of defoliation on yield components and grain quality of maize.

Materials and methods

The experiment was laid out in split plot design with three replications where main plot included stage of defoliation that included two treatments 30 DAS and 40 DAS and sub plot included defoliation of leaves that included four treatments i.e. tassel removal before pollen shedding, 50 % of leaf removal below the ear, 100% of leaf removal below the ear and control. The variety was Manakama-4. Sowing was carried out in 31^{st,} May, 2020. Area of sub plot was of 16.8m^2 and main plot area was 67.2m^2. Fertilizer was applied @120:60:40 kg N, P_2O^5 and K_2O ha^{-1}. Two seeds/hill was sown and thinned out one plant after 15 days of sowing. Seed rate was used @25 kg/ha. Data were recorded as protocol developed by NWRP. Data were analyzed by using R stat.

Results and discussion

There was no any significant difference of defoliation, stage of defoliation and their interaction in phenological traits, stalk yield and grain yield, plant height, cob diameter, cob length, number of grain/cob, number of cob/plant, number of row/cob, final plant stand/plot, barrenness percentage and TGW. Significant difference was observed in SPAD reading at 60 DAS was noted where highest SPAD reading was recorded in 50 percent leaf removal below the ear and lowest in control. Detail results are presented in the table 2, 3 and 4.

Table 2. Effect of defoliation on phenology, yield attributes and grain yield of maize, Khumaltar.

Treatments	Yield attributes											Phenology		Yield	
SD (A)	PH (cm)	NR /cob	DC (cm)	EL (EH) (cm)	CL (cm)	St. (%)	NG/ cob	NPS /plot	NC/ plant	Bar (%)	TGW (g)	DT (50%)	DS (50%)	SY (tha^{-1})	GY (tha^{-1})
30 DAS	178.1	12	14.25	75.83	11	11.84	234	30	2	12	302	86	92	2.85	2.39
40 DAS	176.2	12	14.65	88.48	10.12	10.55	232	29	1	20	298	86	92	2.9	2.33
P-value	ns	Ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
LSD (0.05)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sem (±)	83.2	0.47	1.11	744.07	12.77	10.57	23.45	49	62.38	480.5	3629.2	5.05E-3	1.81E-3	0.02	0.05
D (B)															
TR	169.82	11	15	74.5	12.05	7.75	233	34	1	13	326.67	86	92	2.88	2.41
50% LRBE	183.97	12	15	104.9	9.7	11.87	233	30	2	20	265	86	92	2.94	2.52
100% LRBE	178.73	11	14	75.33	10.2	12.99	226	30	1	13.17	318.33	86	92	2.99	2.44
Control	176	12	14	73.9	10.32	12.16	241.2	27	1	17.67	290	86	92	2.7	2.36
P-value	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	Ns	ns	ns
LSD (0.05)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sem (±)	198.83	0.72	0.74	999.82	8.4	37.27	11.84	49.29	0.81	62.42	2391.7	5.05E-1	1.82E-3	0.55	0.06
A*B	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV%	6.55	6.2	6.65	35.85	30.6	41.75	17.65	24.5	6.65	49.5	18.2	0	0	15.6	10.15
Grand mean	177.13	12.3	14.45	82.16	10.57	11.19	233.24	30.08	1.33	15.96	300	86	92	2.88	2.36

Note=PH=Plant height, NR=Number of row, DC=Diameter of cob, EL=Ear length, CL=Cob length, NG=Number of grain, St. sterility percent, NPS=Number of plant stand, NC=Number of cob, Bar=Barenness, TGW=Thousand grain weight, DT=Days to tasseling, DS=Days to silking, LRBE=Leaf removal below ear, DAS=Days after sowing,SD=Stage of defoliation, TR=Tassel removal, D=Defoliation

Table 3. SPAD reading in maize plants at different time interval, Khumaltar

Treatments	SPAD reading			
SD	SPAD reading 30 DAS	SPAD reading 60 DAS	SPAD reading 90 DAS	SPAD reading 120 DAS
30 DAS	13.79	33.07	36.01	23.95
40 DAS	35.29	29.94	35.85	25.54
P-value	ns	ns	ns	ns
LSD (0.05)	-	-	-	-
Sem (±)	90.67	11.58	71.29	2.27
Defoliation				
TR	40.84	30.84^{bc}	35.33	23.51
50% LRBE	37.94	33.87^{a}	38.55	25.27
100% LRBE	36.37	29.47^{c}	35.65	25.04
Control	35.03	31.84^{ab}	34.21	25.17
P-value	ns	**	ns	ns
LSD (0.05)	-	-	-	-
Sem (±)	19.49	2.86	7.99	5.97
A*B	ns	ns	ns	ns
CV%	18.6	8.1	15.7	8
Grand mean	37.55	31.5	35.94	24.75

Note: DAS= days after silking, SD=Stage of defoliation, LRBE=Leaf removal below ear, TR=Tassel removal

Table 4. Stage of defoliation of leaves/plant at different time interval, Khumaltar

Treatments	No of leaves/plant			
Stage of defoliation	No of leaves/ plant (30DAS)	No of leaves/ plant (60DAS)	No of leaves/ plant (90DAS)	No of leaves/ plant (120DAS)
30 days after silking	7.62	9.55	11.15	2.67
40 days after silking	7.55	9	12.07	2.42
P-value	ns	ns	ns	ns
LSD (0.05)	-	-	-	-
Sem (±)	1.83	1.99	1.48	0.32
Defoliation				
Tassel removal	7.5	9.2	11.93	2.5
50% of leaf removal below the ear	7.73	9.8	11.37	2.5
100% of leaf removal below the ear	7.7	8.97	11.1	2.5
Control	7.4	9.13	12.03	2.67
P-value	ns	ns	ns	ns
LSD (0.05)	-	-	-	-
Sem(±)	0.56	0.68	0.81	0.32
A*B	ns	ns	ns	ns
CV%	13.8	12.05	9.1	18.05
Grand mean	7.58	9.28	11.6	2.54

3.2 MORPHOLOGY AND TAXONOMY

3.2.1 Agro-morphological characteristics study of hill varieties of rice (*Oryza sativa L*

Introduction:

Rice (*Oryza sativa L.*) is one of the most important food crop among the cereals in Nepal. It occupied of 1491744 ha of land with production and productivity of 5610011mt and 3.76t/ha respectively (MoALD, 2018/2019). Newly developed varieties/genotypes must be distinct, uniform and stable. Varieties are mainly identified with respect to their morpho-physiological attributes. With the introduction of high yielding varieties/genotypes and new technologies becoming a great threat to secure the age-old practice of growing traditional varieties and landraces which may have immense potential for different important traits.

Repeated use of same breeding lines with similar genetic base in variety development program not only narrowing down the genetice base but also invite new problems associated with biotic and abiotic stresses. Qualitative characters are considered as morphological markers in the identification of landraces of rice because they are less influenced by environmental changes and the most common approach utilized to estimate relationships between genotypes. The rice pure lines which possess exclusive variability and unique features need to conserve and utilization in future rice breeding program to develop new rice varieties for issues like intellectual property rights.

Objective:

- To develop descriptors of the promising genotypes that helps the seed producers, crop inspectors and respective commodity breeders to maintain genetic purity.
- To support variety release and registration process.

Materials and methods

Seven promising rice genotypes viz. NR-11115, NR-11139, NR-10676, NR-11011, NR11105, 08FAN10 and standard check variety Khumal-4 received from NPBGRC for agro-morphological characterization during summer season 2019/20. Experiments were conducted at field of NSSTRC and rice field of NPBGRC, Khumaltar. These experiments were laid out in RCBD with three replications. Seedlings were raised in dry bed nursery using 50 kg seed ha^{-1}. Seeding was done on 4th June, 2020 and transplanting was done in puddled field on 29th June, 2020. The recommended dose of chemical fertilizer was @ 100:30:30 kg N:P:K ha^{-1} . Half dose of N, K_2o and P_2o^5 was used as basal dose. Remaining dose of N was used in two splits doses and top dressed at the time of tillering stage and booting stage. Sub plot size was 2.2m*3m with 20 cm*20 cm crop geometry. Data were recorded from the net harvested area (NHA) from each sub plot. Five hills were randomly selected from NHA of each sub plot and hills tagged for data

recording. Interculture operations were carried out at different crop stages as an when required. The qualitative, quantitative and biochemical traits were recorded according to UPOV guide lines. Additional traits were also studied viz., flag leaf length, flag leaf width, ligule length, culm number, no. of filled grains, no. of hulls, yield per panicle, chlorophyll reading, date of booting, heading, flowering, maturity and straw yield.

Results and discussion

Variation in qualitative traits

Significant variations were observed in most of the qualitative traits. Among seven genotypes, NR11011 differed due to presence of purple pigmented basal leaf sheath colour with medium green color leaves, purple pigmented tips only compared to check variety Khumal-4 was lacked anthocyanin color in leaf sheath and leaf.Genotypes namely; NR11011, NR10676 and 08FAN10 had strong leaf blade pubescence over the check variety. Pigmented (purple) auricle, collar and ligule colour observed in NR11011. Flag leaf attitude at early growth stage was semi-erect in NR11115, NR11139, NR10676 and NR11011 and erect in rest of the genotypes. Erect culm was observed in NR-11115, NR-10676 and 08FAN10 where semi-erect culm habit was observed in check variety Khumal-4. Purplish stigma, node and internode colour was present in NR-11011. Medium sized purplish awn with purple tipped lemma presented in NR11011 at early stage and awns were distributed in whole length of panicle. At later stage this purple tipped awn turned black. Genotypes NR11011 and 08FAN10 had semi-upright panicle attitude while check variety Khumal 4 had drooping type of panicle attitude. NR11115, NR11011, NR10676 had type 2 secondary branching, NR11105, 08FAN10 had type 1 secondary branching while Khumal-4 had type 3 secondary branching. Detail results are given in table 5.

Table 5: Variation in qualitative characteristics of promising rice genotypes evaluated in mid-hill environment, Khumaltar

Genotype	Basal leaf: Sheath colour	Leaf : Intensity of green colour	Leaf: Anthocyanin colouration	Leaf: Distribution of anthocyanin colouration	Leaf sheath: Anthocyanin colouration	Leaf sheath: Intensity of anthocyanin colouration	Leaf blade: Pubescence of surface	Leaf: Anthocyanin colouration of auricles	Leaf:Anthocyanin colouration of collar	Leaf: Colour of ligule	Flag leaf: Attitude of blade (early observation)	Culm habit	Spikelet: Colour of stigma	Stem: Anthocyanin colouration of nodes	Stem: Intnsity of anthocyanin colouration
NR11115	Green	V.weak	Absent	Awnless	Absent	Very weak	Medium	Absent	Absent	Colorless	Semi-erect	Erect	Yellow	Absent	Absent
NR11139	Green	V.weak	Absent	Awnless	Absent	Very weak	Weak	Absent	Absent	Colorless	Semi-erect	Semi-erect	Yellow	Absent	Absent
NR10676	Green	V.weak	Absent	Awnless	Absent	Very weak	Strong	Absent	Absent	Colorless	Semi-erect	Erect	Yellow	Absent	Absent
NR11011	Purple	Medium	Present	On tips ony	Present	Strong	Strong	Present (Purple	Present (Purple)	Light purple	Semi-erect	Semi-erect	Purple	Present	Strong
NR11105	Green	V.weak	Absent	Awnless	Absent	Very weak	Medium	Absent	Absent	Colorless	Erect	Semi-erect	Yellow	Absent	Absent
08FAN10	Green	V.weak	Absent	Awnless	Absent	Very weak	Strong	Absent	Absent	Colorless	Erect	Erect	Yellow	Absent	Absent
Khumal4	Green	V.weak	Absent	Awnless	Absent	Very weak	Absent or v.weak	Absent	Absent	Colorless	Erect	Semi-erect	Yellow	Absent	Absent

Contd…..

Genotype	Stem:Anthocyanin colouration of internodes	Panicle:Distribution of awns	Panicle:Colour of awn (early observation)	Spikelet:Pubescence of lemma	Spikelet:Color of tip of lemma	Panicle:Attitude in relation to stem	Panicle:Colour of awn (late observation)	Panicle:Type of secondary branching	Panicle:attitude of branches	Leaf: time of senescence	Lemma:Intensity of phenol reaction	Decorticated grain aroma
NR11115	Absent	Awnless	Gold	Medium	Yellowish	Slightly drooping	Gold	Type 2	Semi-erect	Medium	Absent	Absent
NR11139	Absent	Awnless	Gold	Weak	Yellowish	Slightly drooping	Gold	Type 3	Erect	Medium	Absent	Absent
NR10676	Absent	Awnless	Gold	Strong	Yellowish	Slightly drooping	Gold	Type 2	Erect	Early	Present	Absent
NR11011	Present	Whole length	Puple	V.strong	Purple	Semi-upright	Black	Type 2	Erect	Late	Present	Absent
NR11105	Absent	Awnless	Gold	Strong	Yellowish	Drooping	Gold	Type 1	Erect	Early	Present	Absent
08FAN10	Absent	Awnless	Gold	Strong	Yellowish	semi-upright	Gold	Type 1	Erect	Late	Absent	Present
Khumal4	Absent	Awnless	Gold	V.strong	Yellowish	Drooping	Gold	Type 3	Erect	Early	Absent	Absent

Fig. 4: Pigmented auricle and ligule in NR-11011

Variation in quantitative traits

The results of ANOVA revealed that, significant variation observed in quantitative traits like flag leaf width, phenological traits and TGW. Flag leaf width was highest (1.29cm) in NR11115 and lowest (0.87cm) in check variety Khumal4. Early genotype wasNR11011interms of heading, flowering and maturity and most delayed genotype was NR11105. Similarly maximum TGW was of 27.15gm in NR11105 and minimum was of 17.24 gm in NR10676. Detail results are given in table 6.

Table 6. Variation in quantitative traits of rice genotypes evaluated in mid hill environment, Khumaltar

Genotypes	PH (cm)	PdL (cm)	PL (cm)	CN/ hill	CD (mm)	FLL (cm)	FLW (cm)	LBL (cm)	LBW (cm)	GL1 (mm)	GL2 (mm)	GW (mm)	DCGL (mm)	DCGW (mm)	NG/ panicle	St. (%)	DH	DF	DM	TGW	SY	GY
NR 11115	145.46	9.4^{a}	25.33	12.4	5.6	35.47	1.29^{a}	42.8	1.1	2.84	8.88	2.42	6.41	2.22	126	24	69^{b}	70^{b}	102^{b}	21.48^{c}	10.73	1.69
NR 11139	140.73	8.07^{ab}	30.07	10.27	5.94	32.37	1.22^{ab}	39.73	1.03	2.55	8.61	2.43	6.14	2.26	153	33.33	69^{b}	70^{b}	102^{b}	19.02^{f}	15.55	1.94
NR 10676	137.93	8.73^{ab}	25.8	13.33	5.42	32.33	1.12^{ab}	37.67	1.05	2.5	8.35	2.51	5.91	2.32	132	24.87	60^{c}	61^{c}	93^{c}	17.24^{g}	15.09	1.99
NR 11011	132.67	6.40^{ab}	28.73	9.73	6.13	28.07	1.04^{bc}	51.27	1	2.79	9.23	2.52	6.59	2.29	113	36	56^{d}	57^{d}	89^{d}	20.22^{d}	18.47	1.64
NR 11105	136.93	5.40^{b}	30.27	7.73	5.29	26.6	1.19^{ab}	50.6	0.95	2.76	8.94	2.49	6.38	2.29	137	31.53	79^{a}	81^{a}	113^{a}	27.15^{a}	8.35	2.14
08 FAN 10	133.67	8.40^{ab}	28.53	10.89	5.21	32.8	1.19^{ab}	39.13	1.18	2.6	9.21	2.43	6.57	2.2	128	27.07	79^{a}	81^{a}	113^{a}	26.91^{b}	3.82	2.91
Khumal 4	133.13	6.73^{ab}	28.6	10.6	5.61	26.8	0.87^{c}	48.27	0.96	2.6	8.6	2.4	6.14	2.25	191	24.33	69^{b}	70^{b}	102^{b}	19.64^{e}	13.93	2.58
Mean	**137.22**	**7.59**	**28.19**	**10.43**	**5.6**	**30.9**	**1.13**	**44.21**	**1.04**	**2.66**	**8.83**	**2.46**	**6.31**	**2.27**	**140.15**	**28.73**	**68.67**	**69.95**	**101.95**	**20.22**	**12.28**	**2.13**
P-value	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	*****	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	*****	*****	*****	*****	**ns**	**ns**
LSD (0.5%)	**-**	**-**	**-**	**-**	**-**	**-**	**0.22**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.4**	**0.4**	**0.4**	**0**	**-**	**-**
CV (%)	**10.16**	**28.55**	**9.14**	**29.97**	**10.83**	**18.99**	**14.7**	**21.39**	**16.1**	**10.45**	**5.94**	**6.1**	**7.19**	**5.68**	**33.48**	**35.45**	**11.95**	**12.28**	**8.42**	**16.98**	**25.91**	**29.68**

Note: PH= Plant height, PdL= Peduncle length, PL= Panicle length, CN= Culm number, CD= Culm diameter, FLL= Flag leaf length, FLW= Flag leaf width, LBL= Leaf blade length, LBW= Leaf blade width, GL1= Glume length, GL2= Grain length, GW= Grain width, DCGL= Decorticated grain length, DCGW= Decorticated grain width, NG/p= Number of grains per panicle, St.= Sterility %, DH= Days to 50% heading, DF= Days to 50% flowering, DM= Days to 50% maturity, SY=Straw yield, GY= Grain yield.

3.2.2 Agro-morphological characteristics study of wheat genotypes, Khumaltar

Introduction

Wheat (*Triticum aestivum* L.) is third major food crop next to rice and maize in Nepal. It was cultivated on 703992 ha of land with production of 2005665mt and productivity of 2.85t/ha. It contributes significant role in the agricultural system of Nepal. The uniqueness of a particular variety is to be established by the test called DUS. In Nepal, DUS testing is basic requirement to prepare descriptor for easy understanding of the traits and varietal identification characters by all concerned stakeholders. The conservation and characterization of these genetic resources is a necessity not only for posperity, but also for utilization in different varietal improvement programs. These will be useful for breeders, researchers and farmers to identify and choose the restoration and conservation of beneficial genes. Morphological characterization is the foundation of genetic diversity research at any taxonomic level. It is still an important tool for the management of crop germplasm collections. It has been used to identify duplicates, to discriminate among germplasm from different geographic areas, to establish core collections, to investigate relationships between landraces and their wild forms and relatives, prioritize germplasm to use in breeding programmes. Agro-morphological characterization of genotypes/varieties as a series of works have been carried out and the descriptors of the pipeline genoypes of wheat made available to support in variety registration and release process.

Materials and methods

A total of twelve promising genotypes namely; WK2257, WK2430, WK2432, WK2551, WK2602, WK2669, WK2777, WK3025 W3027, WK2748, WK3026 and standard check variety WK1204 were received from NPGRC and characterized by NSSTRC, Khumaltar during winter season 2019/2020. This experiment was laid out in RCBD with three replications and twelve treatments. Recommended seed rate was 120kg/ha. Seeding was done on 1st, Dec, 2019. The plot size was of 1.25m×3m with a spacing of 25cm*continuous. Recommended dose of chemical fertilizer was applied @120:60:40 Kg NPK ha^{-1}. Half dose of N and full dose of P_2O^5 and K_2O was applied as a basal dose and remaining half of N was divided in to two split doses i.e. first half was applied at tillering stage and remaining half at booting stage. Irrigation was managed possibly as per the need up to grain filling stage. Quantitative and qualitative data were recorded from the net harvested area from each plot excluding the boarder rows. Five randomly selected tillers/hills tagged with marker to record the data. Data were processed and analyzed by using R stat.

Results and discussion

Variation in quantitative traits

A significant variation was observed for most of the qualitative traits. Foliage colour was light green in WK-2257 while check variety WK-1204 had dark green foliage. Hairs on auricle was strongly present in WK2669 and absent in WK2777. Frequency of plants with recurved flag leaves ranged from high to very high in all genotypes while WK1204 had low recurved flag leaf. Flag leaf attitude was drooping type in WK2430, WK2432, WK2551, WK2777 and WK3026 and semi-erect in remaining genotypes. Glaucosity of sheath was strong in WK2669, WK3027, WK2557, WK2430, WK2669 and absent in WK2432, WK2551, WK2777. Ear glaucosity was strong in WK3027 and weak in WK2432, WK2602, WK2777 and WK3025. Culm glaucosity ranged from medium to strong among the genotypes. Similarly straw pith in cross section also varied from thin to medium. Ear density was very dense in WK2432, WK2602, WK 2669 and lax in WK3025. Genotype WK2669 was awnless. Awn attitude at heading stage was spreading type in WK2557, WK2430, WK2432, WK3025 and appressed type in check variety WK1204. Outer glume pubescent was present in WK2777, WK3025, WK3206 and absent in check variety WK1204. Lower glume shoulder width was narrow and elevated in WK2557, narrow and sloping in WK2432, WK2551 and WK2602 and very broad and straight in WK2669, WK3027. Lower glume beak shape ranged from curved to straight. Lower glume extent of internal hairs was strong in WK2777, WK3026 and weak in WK1204. Spike attitude was bent in WK2430, WK2432, WK2602, WK2777, WK3025, WK3027, WK2748, WK 3026 and straight in WK1204. Grain mark was absent in WK2430, WK2432, WK2669, WK2777, WK2748, WK3026 and present in check variety WK1204. Detail results are illustrated in table 7.

Table 7: Variation in qualitative characteristics of promising wheat genotypes during agro-morphological characterization, Khumaltar

Genotypes	Foliage: colour	Flag leaf: hairs on auricle	Plant: frequency of plants with recurved flag leaves	Flag leaf attitude	Flag leaf: glaucosity of sheath	Waxiness of sheath	Ear glaucosity	Culm: Glaucosity of neck	Straw pith in cross section	Ear density	Awns or scurs presence	Awns or scurs at tip of ear: length
WK1204	Dark green	Medium	Low	Semi-erect	Medium	Strong	Medium	Strong	Thin	Medium	Awn present	Both
WK2257	Light green	Medium	High	Semi-erect	Strong	Strong	Medium	Strong	Thin	Medium	Awn present	Both
WK2430	Green	Medium	V.high	Drooping	Strong	Strong	Medium	Strong	Medium	Medium	Awn present	Both
WK2432	Green	Absent	High	Drooping	Absent	Medium	Weak	Medium	Thin	Dense	Awn present	Both
WK2551	Green	Medium	High	Drooping	Absent	Medium	Medium	Strong	Medium	Medium	Awn present	Both
WK2602	Green	Medium	High	Semi-erect	Weak	Medium	Weak	Medium	Medium	Dense	Awn present	Both
WK2669	Green	Strong	Medium	Semi-erect	Strong	Strong	Medium	Strong	Medium	Dense	Scur present	Awnless
WK2777	Green	Absent	V.high	Drooping	Absent	Medium	Weak	Medium	Medium	Medium	Awn present	Both
WK3025	Dark green	Medium	V.high	Semi-erect	Medium	Strong	Weak	Strong	Medium	Lax	Awn present	Both
WK3027	Dark green	Medium	High	Semi-erect	Strong	Strong	Strong	Strong	Medium	Medium	Awn present	Both
WK2748	Green	Medium	High	Semi-erect	Weak	Medium	Weak	Strong	Medium	Medium	Awn present	Both
WK3026	Dark green	Medium	V.high	Drooping	Weak	Medium	Medium	Strong	Medium	Medium	Awn present	Both

Contd…

Genotypes	Awn attitude (heading)	Awn attitude (maturity)	Ear colour	Outer glume pubescence	Apical rachis segment: hairiness of convex surface	Lower glume shoulder width	Lower glume shoulder shape	Lower glume beak shape	Lower glume:Extent of internal hairs	Lowest lemma beak shape	Spike attitude at maturity	Grain mark
WK1204	Appressed	Medium	Colored	Absent	Medium	Broad	Straight	Slightly curved	Weak	Slightly curved	Straight	Present
WK2257	Spreading	Appressed	Colored	Absent	Medium	Narrow	Elevated	Straight	Weak	Slightly curved	Straight	Present
WK2430	Spreading	Medium	Colored	Absent	Strong	Broad	Straight	Straight	Weak	Slightly curved	Bent	Absent
WK2432	Spreading	Medium	Colored	Absent	Medium	Narrow	Sloping	Straight	Weak	Slightly curved	Bent	Absent
WK2551	Appressed	Medium	Colored	Absent	Medium	Narrow	Sloping	Straight	Weak	Straight	Straight	Present
WK2602	Appressed	Appressed	Colored	Absent	Medium	Narrow	Sloping	Slightly curved	Weak	Straight	Bent	Present
WK2669	Absent	Appressed	White	Absent	Weak	Very broad	Straight	Straight	Absent or v.weak	Slightly curved	Straight	Absent
WK2777	Appressed	Appressed	Colored	Present	Medium	Narrow	Sloping	Straight	Strong	Straight	Bent	Absent
WK3025	Spreading	Medium	Colored	Present	Medium	Broad	Straight	Straight	Weak	Slightly curved	Bent	Present
WK3027	Appressed	Medium	Colored	Absent	Medium	Very broad	Straight	Straight	Weak	Slightly curved	Bent	Present
WK2748	Appressed	Medium	Colored	Absent	Weak	Broad	Straight	Slightly curved	Weak	Straight	Bent	Absent
WK3026	Appressed	Medium	Colored	Present	Weak	Broad	Elevated	Slightly curved	Strong	Slightly curved	Bent	Absent

Variation in quantitative traits

A significant difference in most of the quantitative traits were observed. Lower glum beak length was maximum (10.94 mm) in WK 3026 which was at par with check variety WK 1204 (9.87mm) and minimum in WK 2669 (0.65mm). Highest spikelet length was of WK2551 (11.44 cm) and lowest (8.97cm) of WK3026. Sterile spikelets at base was highest (3) in WK3026 and lowest (1) in WK 3025. Tallest plant height (107.40cm) was observed in WK2602 and shortest (91.93cm) in WK 3026. Spike length, awn length, peduncle length was maximum in WK 2777 and minimum spike length, awn length was in WK 3026 and peduncle length in check variety WK1024. Flag leaf length and width was longest in WK 2777 and WK 1204 and shortest in WK 2403 and WK 2257. Number of effective tillers were significantly highest (11) in WK2257 and lowest (6) in WK 2602. WK 2551 had maximum (64) number of grains per spike and WK 2257 had minimum (38) number of grains. Early genotype was WK3025 and that was matured in 161 days. Longest (6.94mm) seed length was of WK 2777 and shortest (6.32mm) of WK 3025. Maximum seed depth was of WK 3025 and minimum in WK 2257 and WK 2403. Sterility % was highest (49.10%) in WK2748, WK3026 (49.10%) and lowest (38.78%) in WK2602. A significant difference observed in straw yield. Highest straw yield produced by WK 2403 (8.26tha^{-1}) and lowest by WK3025 (5.52tha^{-1}). There was not significant difference observed in grain yield among the genotypes. Detail results are given in table 8.

Table 8: Variation in quantitative characteristics of promising wheat genotypes, Khumaltar

Genotypes	LG:BL (mm)	SL (cm)	No.SSB	No.S/S	PH	EL	AL (cm)	PL (cm)	FLL (cm)	FLW (cm)	No.ET	CD (mm)	No.GA	No.G/ S1	No.G/ S2	DH (80%)	DM (80%)	SL (mm)	SW (mm)	SD (mm)	WG/S	TGW (g)	SY (t/ha)	GY (t/ha)	S (%)
WK1204	9.87^{a}	10.49^{ab}	3^{abc}	17^{bc}	96.60^{f}	11.29^{cde}	6.08^{bcd}	10.40^{e}	20.10^{ab}	1.90^{a}	10^{ab}	4.9^{ab}	1^{a}	4^{a}	48b^{cde}	127	176^{a}	6.54^{bcd}	3.77^{a}	3.21^{a}	2.72^{def}	56.67^{abc}	6.07^{bc}	4.05	37.74^{bc}
WK2257	5.95^{ab}	9.13^{cd}	3^{abcd}	15^{cd}	106.07^{d}	10.53^{ef}	5.89^{cd}	16.59^{cd}	21.05^{ab}	1.39^{f}	11^{a}	4.03^{fg}	2^{ab}	4^{a}	38^{f}	119	169^{bc}	6.72^{abc}	3.63^{a}	2.81^{c}	2.67^{def}	63.33^{a}	7.02^{abc}	4.48	35.74^{bc}
WK2403	3.19^{def}	9.17^{cd}	2^{cd}	16^{cd}	98.47^{ef}	10.22^{f}	5.61^{d}	14.10^{de}	15.34^{d}	1.55^{def}	9^{abcd}	4.20^{efg}	1^{a}	3^{b}	49^{bcd}	118	176^{a}	6.42c^{d}	3.72^{a}	3^{abc}	2.97^{cdef}	53.33^{bc}	8.26^{a}	5.1	35.12^{bc}
WK2432	4.65^{bcd}	10.10^{bc}	2^{bcd}	16^{cd}	98.47^{ef}	11.31^{cde}	5.81^{d}	14.91^{d}	15.79^{cd}	1.60^{cde}	8de	4.05^{fg}	2^{a}	3^{b}	56a^{b}	115	166^{c}	6.83^{ab}	3.86^{a}	3.02^{abc}	3.67^{ab}	60.00^{ab}	6.51^{abc}	4.79	37.20^{bc}
WK2551	2.35^{f}	11.44^{a}	3^{ab}	19^{ab}	129.93^{b}	12.34^{ab}	6.57^{b}	20.20^{bc}	20.17^{ab}	1.91^{a}	9^{cde}	5.10^{a}	2^{ab}	4^{a}	64^{a}	123	176^{a}	6.69^{abcd}	3.66^{a}	2.97^{bc}	3.80^{a}	56.67^{abc}	7.07^{ab}	4.86	41.31^{ab}
WK2602	5.09^{bc}	11.00^{ab}	3^{abcd}	19^{a}	107.40^{d}	12.02^{abc}	6.03^{bcd}	17.03^{cd}	20.59^{ab}	1.71^{bcd}	6^{f}	4.72^{def}	2^{ab}	3^{b}	47^{bcde}	117	176^{a}	6.45b^{cd}	3.32b	2.84bc	3.0^{cdef}	53.33^{bc}	7.12^{abc}	4.17	38.78^{b}
WK2669	0.65^{g}	10.50^{ab}	3^{abcd}	17^{bcd}	115.87^{c}	12.58^{a}	3.27^{e}	17.03^{cd}	21.53^{ab}	1.80^{ab}	9^{cde}	4.72^{abc}	2^{ab}	3^{ab}	53b^{c}	127	176^{a}	6.41^{cd}	3.6^{a}2	3.01^{abc}	3.07^{cde}	53.33^{bc}	7.84^{ab}	4.49	36.43^{bc}
WK2777	3.74^{cdef}	11.19^{ab}	3^{abc}	17^{bc}	141.27^{a}	12.60^{a}	7.73^{a}	31.30^{a}	22.87^{a}	1.72^{bc}	9^{abcd}	4.72^{abc}	2^{a}	3^{b}	49^{bcd}	116	166^{c}	6.94^{a}	3.79^{a}	3.03^{abc}	3.40^{abc}	60.00^{ab}	7.69^{ab}	5.16	37.51^{bc}
WK3025	5.61^{b}	10.10^{bc}	1^{e}	15^{cd}	110.87^{cd}	10.82^{ef}	6.55^{b}	23.68^{b}	19.49^{b}	1.45^{ef}	8^{e}	4.13^{efg}	2^{c}	3^{b}	41^{def}	113	161^{d}	6.32^{d}	3.59^{ab}	3.20^{a}	2.60^{ef}	53.33	5.52^{c}	3.6	20.84^{d}
WK3027	2.78^{ef}	10.10^{bc}	2de	15^{cd}	104.73^{de}	11.77^{abc}	6.49^{bc}	15.03^{d}	21.61^{ab}	1.75^{abc}	8^{ef}	4.42^{cdef}	2^{a}	3^{ab}	47^{cde}	123	172^{b}	6.44^{bcd}	3.68^{a}	2.89^{bc}	2.87^{cdef}	56.67	6.38^{bc}	4.14	28.99^{cd}
WK2748	4.39^{bcde}	10.33^{b}	2^{cd}	15^{cd}	109.20^{cd}	11.59^{bcd}	5.90^{cd}	15.57^{d}	18.81^{bc}	1.52^{ef}	9^{bcde}	4.48^{bcde}	1.73^{ab}	3^{b}	44^{cdef}	122	176^{a}	6.97^{a}	3.66^{a}	3.07^{ab}	3.20^{bd}	60	7.75^{ab}	4.68	49.10^{a}
WK3026	10.94^{a}	8.97^{d}	3^{a}	15^{d}	91.93^{f}	10.33f	5.80^{d}	16.49^{cd}	16.05^{cd}	1.47^{ef}	10^{abc}	3.85^{g}	2^{b}	3^{b}	39^{ef}	119	169^{bc}	6.35^{cd}	3.57^{ab}	2.89^{bc}	2.47^{f}	50.55	5.70^{c}	4.06	49.10^{a}
Mean	**4.93**	**10.21**	**2.57**	**16.31**	**109.87**	**11.44**	**5.97**	**17.71**	**19.45**	**1.65**	**8.58**	**4.4**	**1.81**	**3.22**	**47.82**	**119**	**172**	**6.59**	**3.66**	**2.99**	**3.03**	**63.89**	**6.96**	**4.47**	**35.92**
P-value (0.5)	***	**	**	**	***	***	***	***	***	***	***	***	**	Ns	***	Ns	***	*	ns	*	**	ns	*	ns	**
LSD	**1.63**	**1.08**	**0.74**	**2.32**	**7.51**	**0.92**	**0.64**	**4.42**	**3.17**	**0.17**	**1.2**	**0.41**	**0.31**	-	**8.93**		**4.04**	**0.39**	-	**0.22**	**0.58**	-	**1.84**	-	**9.31**
CV (%)	**13.09**	**9.56**	**23.81**	**11.81**	**12.75**	**8.43**	**17.64**	**32.19**	**16.64**	**11.85**	**14.67**	**14.04**	**14.04**	**13.09**	**18.24**	**5.42**	**3.19**	**4.4**	**5.27**	**5.49**	**16.58**	**9.62**	**19.45**	**16.61**	**23.91**

Note: LG:BL= Lower glume: Beak length, SL= Spikelet length, No.SSB= No. of sterile spikelet at base, No.S/S=No. of spikelet/spike, PH= Plant height (including awn), EL=Ear length (including awn), AL=Awn length (cm), PL= Peduncle length (cm), FLL=Flag leaf length (cm), FLW= Flag leaf width (cm), No.ET=No. of effective tillers (number), CD= Culm diameter (mm), No.GA= No. of grains at apex, No.G/S1=No. of grains/spikelet, No.G/S2=No of grains/spike, DH= Days to 80% heading, DM= Days to 80% maturity, SL= Seed length (mm), SW= Seed width (mm), SD= Seed depth (mm), WG/S=Wt. of grains/spike, TGW= 1000 Grain Weight (g), SY=Straw Yield, GY=Grain Yield, S= Sterility percent.

3.2.3 Agro-morphological characteristics study of promising finger millet genotypes

Introduction

Finger millet (*Eleusine coracana* Gaertn) is an annual herbaceous plant belonging to tribe Eragrostidae and family Poaceae. It is a tetraploid (2n=4x=36) and self-pollinating species probably evolved from its wild relative *Eleusine Africana*. It is the fourth most important food crop in mid hills and high hills of Nepal and plays a vital role in the livelihood in these areas.The total cultivated area of finger millet was 263261ha of land with production of 314225mt and productivity 1.19t/ha (MoALD, 2018/2019). It is pre-dominantly grown under maize/millet relay system in mid-hills of western, central and eastern regions whereas in the hilly areas of mid and far western region, it is grown as mono crop. Characterization was done by NSSTRC to achieve the following objectives.

Objective:

- To characterize the released and pre release genotypes for variety identification and registration process.
- To maintain the genetic purity of released and prerelease varieties/genotypes.

Materials and methods

Released and prerelease varieties/genotypes were received from Hill Crops Research Program, Kabre, Dolakha. Trial was laidout in RCBD with three replications. Eight varieties/genotypes namely; Dalle-1, Okhle-1, Kabre kodo-1, KLE-158, Kabre kodo-2, Sailung kodo-1, KLE-236 and KLE 159 were characterized at Khumaltar. Area of each plot size was 3.0*5.0 m. Direct sowing was done in lines with 30cm apart on June 14, 2020 (2076/02/31) and maintain 10 cm plant to plant spacing after thinning. Recommended dose of fertilizer 40:30:20 kg N,P_2O_5,K_2O/ha. Remaining practices were followed based on guide lines provided by HCRP.

Results and discussion

Variation in qualitative traits

Different qualitative characteristics were studied. Regarding all these traits, leaf: pubescence, stem: culm branching, flag leaf: blade width, finger: branching, finger: position of branching, finger: multiple whorl, seed shape, seed: surface and pericarp: persistence after threshing were found similar among genotypes. Rest of the traits were significantly differed. Genotypes had erect growth habit except KLE-159 with decumbent growth habit. Genotypes KLE-159, KLE-236 and Sailung kodo-1 had plant: pigmentation at leaf juncture. Likewise all genotypes consisted of leaf sheath pubescence. Dalle-1, Okhe-l, Kabre kodo-1, KLE-158 and Kabre kodo-2 had light glum color and KLE-159, KLE 236 and Sailung kodo-1 had light purple glum color. Similarly

ear head shape was fist of Okhle-1, KLE-159, KLE-236 and Kabre kodo-1 had semi compact ear head. Rest of the genotypes had compact ear head. Seed shattering observed in Kabre kodo-2 and others had not. Enclosed seed covering by glumes observed in Kabre kodo-2 and KLE-158 and others had intermediate. Different seed color were observed in which copper brown found in KLE-159, Sailung kodo-1 and KLE-159. Similarly dark brown seed color was observed in Dalle-1 and Okhle-1 and light brown color in Kavre kodo-2 and white color in KLE-236. This qualitative characterization will be useful in variety release, registration process, seed variety identification and maintenance breeding. Detail results are given in table 9.

Table 9: Variation in qualitative traits of finger millet varieties/genotypes, Khumaltar

Genotypes	Growth Habit	Plant: Pigmentation at Leaf Juncture	Leaf Sheath Pubescence	Glume Color	Stem: Culm Branching	Flag Leaf: Blade Width	Head: Shape	Finger: Branching	Finger: Position Of Branching	Finger: Multiple Whorl	Seed: Shattering	Seed: Covering by Glumes	Seed: Color	Seed: Shape	Seed: Surface	Pericarp:Persistence after threshing
	1. Erect	**1.Absent**	**1.Absent**	**1.White**	**1.Absent**	**3.Narrow (<1)**	**1.First Type**	**1.Absent**	**3.In the Thumb Finger**	**1.Absent**	**1.Absent**	**2.Enclosed**	**2.White**	**1.Round**	**3.Smooth**	**1.non Presistent**
	5. decumbent	**9.Present**	**9.Present**	**3.Light Green**	**9.Present**	**5.Medium (1-2)**	**3.Compact**	**9.Present**	**5.In All The Finger**	**9.Present**	**9.Absent**	**4.Intermediate**	**4.Light Brown**	**3. Reniform**	**7.Rough**	**9.Persistent**
	7. Prostrate			**5.Dark Green**		**7.wide (>2)**	**5.Semi Compact**					**6.Exposed**	**6.Copper Brown**	**5.Ovoid**		
				7.Light Purple			**7.Open**						**8.Dark Brown**			
				9.Dark Purple			**9.Droppy**									
Dalle 1	Erect	Absent	Present	Light green	Absent	Narrow	Compact	Absent	In all the fingers	Absent	Absent	Intermediate	Dark brown	Round	Smooth	Persistence
Okhle 1	Erect	Absent	Present	Light green	Absent	Narrow	Fist type	Absent	In all the fingers	Absent	Absent	Intermediate	Dark brown	Round	Smooth	Persistence
KLE 159	Decumbent	Present	Present	Light purple	Absent	Narrow	Fist type	Absent	In all the fingers	Absent	Absent	Intermediate	Copper brown	Round	Smooth	Persistence
Kabre kodo1	Erect	Absent	Present	Light green	Absent	Narrow	Semi-compact	Absent	In all the fingers	Absent	Absent	Intermediate	Dark brown	Round	Smooth	Persistence
KLE 236	Erect	Present	Present	Light purple	Absent	Narrow	Fist type	Absent	In all the fingers	Absent	Absent	Intermediate	White	Round	Smooth	Persistence
Sailung kodo 1	Erect	Present	Present	Light purple	Absent	Narrow	Compact	Absent	In all the fingers	Absent	Absent	Intermediate	Copper brow	Round	Smooth	Persistence
KLE 158	Erect	Absent	Present	Light green	Absent	Narrow	Compact	Absent	In all the fingers	Absent	Absent	Enclosed	Copper brown	Round	Smooth	Persistence
Kabre kodo 2	Erect	Absent	Present	Light green	Absent	Narrow	Compact	Absent	In all the fingers	Absent	Present	Enclosed	Light brown	Round	Smooth	Persistence

Variation in quantitative traits

Results of ANOVA revealed that tested genotypes were differed highly significant interms of flag leaf blade length, ear head length, finger length, days to heading, plant height, days to maturity and TGW and significant to peduncle length and straw yield. Among the observed traits, KLE-158 had shortest (19.97cm) flag leaf blade length followed by Sailung kodo-1(22.87cm) and KLE-159 (22.90cm) whereas Kabre kodo-1 (29.95cm) had longest flag leaf blade length. Similarly KLE-236 had longest peduncle length of 13.70cm followed by Okhle-1(12.36cm) and KLE-158 (12.53cm). Similarly Kabre kodo-1 produced longest ear head of 10.33cm followed by Okhle-1(8.80cm) and Dalle-1(8.10cm). Likewise Kabre kodo-1 produced longest finger length of 8.67cm followed by Okhle-1 (8.07cm) and KLE-159 (6.93cm). In relation to plant height, KLE-159 was shortest (117.87cm) followed by KLE-158 (124.9cm). Similarly Kabre kodo-2 produced bold grain with TGW of 1.74g followed by KLE159 (1.70g) and Sailung kodo-1(1.41g). Likewise in 50% days to heading, earliest genotype was Kabre kodo-2 (97days) followed by Okhle-1 and KLE-159(103days). Similarly Kabre kodo-2 and Dalle-1 were found earliest in maturity of 144 days followed by Kabre kodo-1(145days). Regarding straw yield, highest straw yield produced by Dalle-1 (2.88t/ha) followed by Kabre kodo-2 (2.77 t/ha), Kabre kodo-1(2.38t/ha) and Sailung kodo-1(2.38 t/ha). Detail results are presented in table 10.

Table 10: Variation in qualitative traits of released and promising finger millet genotypes, Khumaltar

Genotypes	FLBL (cm)	PL (cm)	EHL (cm)	FL (cm)	FW (cm)	NMH /hill	NPT/ Hill	PH (cm)	TGW (g)	DH (50%)	DM (80%)	SY (t/ha)	GY (t/ha)
Dalle-1	27.03^{abc}	10.27^{bc}	8.10^{b}	6.33^{cd}	0.93	6.13	4.07	161.73^{a}	1.16^{c}	106^{c}	144^{b}	2.88^{a}	2.62
Okhle-1	28.89^{ab}	12.63^{ab}	8.80^{ab}	8.07^{ab}	0.93	6.60	3.53	135.53^{c}	1.30^{bc}	103^{cd}	150^{a}	1.87^{c}	1.82
KLE-159	22.90^{de}	9.37^{c}	7.63^{bc}	6.93^{bc}	1.03	5.40	4.20	117.87^{e}	1.70^{a}	105^{c}	149^{a}	2.16^{bc}	2.22
Kabre kodo-1	29.95^{a}	9.83^{c}	10.33^{a}	8.67^{a}	0.93	5.53	3.27	151.80^{ab}	1.40^{b}	108^{bc}	145^{b}	2.38^{abc}	2.73
KLE-236	24.73^{cd}	13.70^{a}	5.79^{d}	5.40^{de}	0.93	5.33	3.53	131.00^{cd}	1.27^{bc}	118^{a}	150^{a}	1.99^{c}	1.60
Sailung kodo-1	22.87^{de}	11.83^{abc}	6.17^{cd}	4.77^{e}	0.93	6.73	3.47	151.47^{b}	1.41^{b}	105c	150^{a}	2.38^{abc}	1.89
KLE-158	19.97^{e}	12.53^{ab}	6.49^{cd}	6.07^{cd}	1.03	5.40	3.93	124.93^{de}	1.26^{bc}	113a	148^{a}	1.89^{c}	2.11
Kabre kodo-2	25.80^{bcd}	11.33^{abc}	6.44^{cd}	5.53^{de}	0.94	5.80	4.07	139.53^{c}	1.74^{a}	97d	144^{b}	2.77^{ab}	2.40
Mean	25.27	11.43	7.46	6.47	0.95	5.86	3.76	139.23	1.40	106.87	147.42	2.29	2.11
P-value	***	*	***	***	ns	ns	ns	***	***	***	***	*	ns
LSD(0.5)	3.64	2.66	1.54	1.16	-	-	-		0.21	6.23	1.83	0.69	-
CV (%)	14.53	16.97	22.36	21.57	8.6	12.97	15.29	11.01	16.0	6.35	1.75	21.63	30.67

Note: FLBL=Flag leaf blade length, PL= Peduncle length, EHL= Ear head length, FL= Finger length, FW= Finger width, NMH=Number of main head, NPT= Number of Productive Tiller, PH= Plant height, TGW= Thousand grain weight, DF= Days to 50% heading, DM= Days to 50% maturity, SY= Straw Yield, GY= Grain Yield

3.2.4 Agro-morphological characteristics study of rapeseed (Tori) (Brassica rapa)

Introduction

Rapeseed (tori) is the important oilseed crop of Nepal. Tori is grown in different agro ecological regions of Nepal. Different types of landraces are grown in different parts of the country. It occupied 260307ha. of land with production and of 280530mt and 1.08t/ha respectively(2018.2019). NAGRC collected large number of local landraces from different districts of Nepal. These genotypes were characterize to achieve the following objectives.

Objectives:

- To characterize the released and pre release genotypes for variety identification release and registration process.
- To maintain the genetic purity of released and prerelease varieties/genotypes.

Materials and methods

A total of 48 genotypes were received from NAGRC, Khumaltar. Characterization was done at NSSTRC, Khumaltar. during winter season 2019/2020. Experiments were laidout in RCBD with two replications at 30 cm apart. Recommended dose of fertilizer was 60:40:20 kg N, P_2O^5, K_2O /ha and rest of the practices were followed based on protocol developed by NORP. The crop was sown on 9 September, 2019 at Khumaltar. Rest of the practices applied based on protocal developed by NORP.

Results and discussion

Variation in qualitative traits

Most of the tested genotypes had hairness leaves except NGRCO 2754 (sparse) and NGRCO2756 (dense). Based on leaf color genotypes NGRCO2752, NGRCO2756, NGRCO2757, NGRCO2749,NGRCO2790, NGRCO2795, NGRCO2797, NGRCO2798, NGRCO2801, NGRCO2807, NGRCO3860, NGRCO4243, Unnati, Surkhet local3, Baltori and Morang tori had leaves with light green color and rest of the genotypes were with medium green leaf color. Regarding leaf length genotypes namely NGRCO2750, NGRCO2751, NGRCO2760, NGRCO2761, NGRCO2781, NGRCO2749, NGRCO2747 and Lumle tori had medium leaf length of 13-15cm and NGRCO 2753 produced long leaf length of >15cm and rest genotypes had short leaf length (12cm). Similarly genotypes NGRCO2750, NGRCO2751, NGRCO2754, NGRCO2758, NGRCO2773, NGRCO2775, NGRCO2777 and Baltori were with long main shot length (51-60cm) whereas NGRCO2757, NGRCO2764, NGRCO2770, NGRCO2783, NGRCO2747,N GRCO2755, 2798, NGRCO2801 and NGRCO2807 had short shot length (<40cm) and rest of the genotypes had medium shot length of 41-<50cm. In relation to siliqua length, genotypes NGRCO2762, NGRCO2763, NGRCO2765, NGRCO2766, NGRCO2768, NGRCO2769, NGRCO2770, NGRCO2771, NGRCO2773 NGRCO2797, NGRCO2798,

NGRCO2801, Vikash and Baltori had long siliqua length of >5.5cm whereas NGRCO2756, NGRCO2775, NGRCO2785, NGRCO2747, NGRCO2749 had short siliqua length of <4.5cm and rest of the genotypes had medium siliqua length of 4.5 to 5.5cm. Genotypes NGRC O2769, NGRCO2787, NGRCO2797 had siliqua length medium beak of 0.8 <12cm and NGRCO2765 had short siliqua length beak of <0.8cm and other genotypes had long beak of >12cm. Regarding number of siliqua on main shot, NGRCO2751, NGRCO2777 had few siliqua (40-<50) and others had very few (<40). Similarly number of seed per siliqua, NGRCO2758, NGRCO2762, NGRCO2763, NGRCO2766, NGRCO2777, NGRCO2779, NGRCO2780, NGRCO2783, NGRCO2787, NGRCO2747, NGRCO2795, NGRCO2797, NGRCO2807, NGRCO3860, NGRCO4243, Vikash, Pragati and Surkhet local3 had very few seed per siliqua of <12 and Morang tori NGRCO2754 had many seed per siliqua of >20. Likewise NGRCO2760, NGRCO2765, NGRCO2767, NGRCO2771, and NGRCO2790 had medium seed per siliqua of 17<2. Detail results are presented in table 11.

Table 11: Variation in qualitative characteristics of different rapeseed genotypes, Khumaltar

Treatments	Leaf hairiness	Leaf colour	Leaf: length(cm)	Main shoot Length (cm)	Siliqua length (cm)	Siliqua length of beck (cm)	Siliqua no of main shoot	No of seed / Siliqua
	1 Absent	**1.light green**	**3.Short(<12)**	**3 Short (<40)**	**3 short (<4.5)**	**3 short (<0.8)**	**3 very few <40**	**3 very few < 12**
	3 Sparse	**2.medium green**	**5.Medium(13-15)**	**5 Medium (41-<50)**	**5 medium (4.5-5.5)**	**5 medium, (0.8-<1.2)**	**5 few 40-<50**	**5 Few 13-<16**
	5.Dence	**3.dark green**	**7.Long(>15)**	**7 Long 51-<60)**	**7 long (> 5.5)**	**7 long (> 1.2)**	**7 medium 51-<60**	**7 Medium 17-<20**
		4.purple green		**9 Very long > 60**			**9 many >60**	**9 Many >20**
NGRC02750	Absent	Medium green	Medium	Long	Medium	Long	Very few	Few
NGRC02751	Absent	Medium green	Medium	Long	Medium	Long	Few	Few
NGRC02752	Absent	Light green	Short	Medium	Medium	Long	Very few	Few
NGRC02753	Absent	Medium green	Long	Medium	Medium	Long	Very few	Few
NGRC02754	Sparse	Medium green	Short	Long	Medium	Long	Very few	Many
NGRC02756	Dense	Light green	Short	Medium	Short	Long	Very few	Few
NGRC02757	Absent	Light green	Short	Short	Medium	Long	Very few	Few
NGRC02758	Absent	Medium green	Short	Long	Medium	Long	Very few	Very few
NGRC02760	Absent	Medium green	Medium	Medium	Medium	Long	Very few	Medium
NGRC02761	Absent	Medium green	Medium	Medium	Medium	Long	Very few	Few
Vikash	Absent	Medium green	Short	Medium	Long	Long	Very few	Very few
NGRC02762	Absent	Medium green	Short	Medium	Long	Long	Very few	Very few
NGRC02763	Absent	Medium green	Short	Medium	Long	Long	Very few	Very few
NGRC02764	Absent	Medium green	Short	Short	Medium	Long	Very few	Few
NGRC02765	Absent	Medium green	Short	Medium	Long	Short	Very few	Medium
NGRC02766	Absent	Medium green	Short	Medium	Long	Long	Very few	Very few
NGRC02767	Absent	Medium green	Short	Medium	Medium	Long	Very few	Medium
NGRC02768	Absent	Medium green	Short	Medium	Long	Long	Very few	Few
NGRC02769	Absent	Medium green	Short	Medium	Long	Medium	Very few	Few
NGRC02770	Absent	Medium green	Short	Short	Long	Long	Very few	Few
NGRC02771	Absent	Medium green	Short	Medium	Long	Long	Very few	Medium
Pragati	Absent	Medium green	Short	Medium	Long	Long	Very few	Very few
NGRC02773	Absent	Medium green	Short	Long	Long	Long	Very few	Few
NGRC02775	Absent	Medium green	Short	Long	Short	Long	Very few	Few
NGRC02777	Absent	Medium green	Short	Long	Medium	Long	Few	Very few

Treatments	Leaf hairiness	Leaf colour	Leaf: length(cm)	Main shoot Length (cm)	Siliqua length (cm)	Siliqua length of beck (cm)	Siliqua no of main shoot	No of seed / Siliqua
	1 Absent	**1.light green**	**3.Short(<12)**	**3 Short (<40)**	**3 short (<4.5)**	**3 short (<0.8)**	**3 very few <40**	**3 very few < 12**
	3 Sparse	**2.medium green**	**5.Medium(13-15)**	**5 Medium (41-<50)**	**5 medium (4.5-5.5)**	**5 medium, (0.8-<1.2)**	**5 few 40-<50**	**5 Few 13-<16**
	5.Dence	**3.dark green**	**7.Long(>15)**	**7 Long 51-<60)**	**7 long (> 5.5)**	**7 long (> 1.2)**	**7 medium 51-<60**	**7 Medium 17-<20**
		4.purple green		**9 Very long > 60**			**9 many >60**	**9 Many >20**
NGRC02779	Absent	Medium green	Short	Medium	Medium	Long	Very few	Very few
NGRC02780	Absent	Medium green	Short	Medium	Medium	Long	Very few	Very few
NGRC02781	Absent	Medium green	Medium	Medium	Medium	Long	Very few	Few
NGRC02783	Absent	Medium green	Short	Short	Medium	Long	Very few	Very few
NGRC02785	Absent	Medium green	Short	Medium	Short	Long	Very few	Few
NGRC02787	Absent	Medium green	Short	Medium	Medium	Medium	Very few	Very few
NGRC02746	Absent	Medium green	Short	Medium	Medium	Long	Very few	Few
Lumle tori	Absent	Light green	Medium	Medium	Medium	Long	Very few	Few
NGRC02747	Absent	Light green	Medium	Short	Short	Long	Very few	Very few
NGRC02749	Absent	Light green	Medium	Medium	Short	Long	Very few	Few
NGRC02790	Absent	Light green	Short	Medium	Medium	Long	Very few	Medium
NGRC02795	Absent	Light green	Short	Short	Medium	Long	Very few	Very few
NGRC02797	Absent	Light green	Short	Medium	Long	Medium	Very few	Very few
NGRC02798	Absent	Light green	Short	Short	Long	Long	Very few	Few
NGRC02801	Absent	Light green	Short	Short	Long	Long	Very few	Few
NGRC02807	Absent	Light green	Short	Short	Medium	Long	Very few	Very few
NGRC03860	Absent	Light green	Short	Short	Medium	Long	Very few	Very few
NGRC04243	Absent	Light green	Short	Medium	Medium	Long	Very few	Very few
Unnati	Absent	Light green	Short	Medium	Medium	Long	Very few	Few
Baltori	Absent	Light green	Short	Long	Long	Long	Very few	Few
Preeti	Absent	Light green	Short	Medium	Medium	Long	Very few	Few
Surkhet local 3	Absent	Light green	Short	Medium	Medium	Long	Very few	Very few
Morong Tori	Absent	Light green	Short	Medium	Medium	Long	Very few	Many

Variation in quantitative traits

Results of ANOVA revealed that all the tested variables were found highly significant among the genotypes. It means that diverse genotypes were included for characterization and these will useful to use in breeding. Regarding grain yield; genotypes Morang tori produced lowest grain yield of 49kg/ha to highest grain yield produced by NGRC02775 412kg/ha. Genotypes NGRC02275 (412 kg/ha), Vikash (400 kg/ha), Pragati (386), NGRC 02275 (366), NGRC02773 (314) and NGRC02765 (303kg/ha) produced higher grain yield over to Unnati (281kg/ha), Preeti (241kg/ha), Surkhet local-3 (154kg/ha), Baltori (113kg/ha) and Morang tori (49kg/ha). A total of seventeen genotypes produced grain yield ranged from 203 kg/ha to 284kg/ha. Similarly TGW was ranged from NGRC02795 (1.1g) to NGRC02765 (2.5g). Other genotypes produced higher TGW were NGRC02770 (2.3g), NGRC02766 (2.2g), Pragati (2.2g), NGRC02749 (2.2g), NGRC02767 (2.1g), NGRC02768 (2.1g), NGRC2797 (2.0g) and Morang tori (2.0g). These genotypes produced TGW over to Preeti (1.8g), Vikash, Lumle tori, Unnati, Baltori (1.7g), Surkhet local (1.4g) and rest of others. Days to flowering ranged from NGRC02765 (18 days) to NGRC02795 and Preeti (25 days). Similarly seed /siliqua ranged from NGRC O2807 and NGRC 3860 (10g) to Morang tori (22g). More number of seed bearing genotypes were Morang tori (22), NGRCO2754 (20) NGRC2765 (20), NGRCO2767 (19) and NGRCO2787 (18). These genotypes had higher number of seed/siliqua over to Preeti, Baltori (16), Lumle tori (14), Unnati, Vikash (12) and Pragati (11). Similarly siliqua number on main shot was ranged from NGRCO2764 (5.27) to Vikash (42.7). Other genotypes with higher number siliqua on main shot were NGRCO2758 (38.3), NGRCO2761 (38.2), NGRCO2751 (34.7), NGRCO2765 (34.7), Pragati (33.7), NGRCO2763 (33.7) and NGRCO2773 (33.7). Likewise siliqua length of beak was ranged from NGRCO2765 (0.7cm) to NGRCO2761 and 2749(2). Other genotypes having longer beak were NGRCO2767(1.9cm), Surkhet local (1.9cm), NGRCO2781(1.8cm), NGRCO2750(1.7cm), NGRCO2753(1.7cm), NGRCO2756 (1.7cm), Vikash(1.7cm), NGRCO2771(1.7cm), NGRCO2777(1.7cm), NGRCO2780 (1.7cm), Lumle tori(1.7cm), NGRCO2790(1.7cm), NGRCO2798(1.7cm), NGRCO2807 (1.7cm). Similarly siliqua length was ranged from NGRCO2764 (4.4cm) to NGRCO2761 (7.1cm). Other genotypes with long siliqua length were NGRCO2790 (6.7cm), NGRCO2746 (6.6cm), Lumle tori (6.5cm), NGRCO2795 (6.4cm), Vikash (6.3cm), NGRCO2781 (6.3cm), NGRCO2780 (6.2cm), NGRCO2783 (6.2cm), NGRCO2807 (6.2cm), NGRCO2762 (6.1cm). Likewise plant height was ranged from Morang tori (60.1cm) to NGRCO2761 (104.7cm) followed by Vikash (101.6cm), and NGRCO2795 (100.4cm). Dwarf genotypes namely Morang tori (60.1cm), NGRCO2752 (62.1cm), NGRCO2767 (64.2cm) etc. were shorter in plant height compared to Lumle tori (84.5cm), Bal tori (75.5cm), Surkhet local3 (81.3cm), Pragati (82.6cm), Unnati (90cm) and Preeti (92.7cm). Detail results are presented in table 12.

Table 12: Variation in quantitative characteristics of released and other rapeseed genotypes, Khumaltar

S.No.	Treatments	Plant height (cm)	Siliqua length (cm)	Siliqua length of beak (cm)	Siliqua no. on main shoot	No. of seed/ siliqua	Days to 50% Flowering	TGW (g)	Grain Yield (kg/ha)
1	NGRC02750	68.7	5.6	1.7	29.5	11	23	1.5	114
2	NGRC02751	78.7	5.7	1.4	34.7	12	22	1.3	258
3	NGRC02752	62.1	5.7	1.5	23.2	14	19	1.9	206
4	NGRC02753	79.9	5.9	1.7	27.1	13	21	1.5	207
5	NGRC02754	83.8	5.2	1.4	31.4	20	22	1.3	171
6	NGRC02756	78.0	5.5	1.7	30.3	16	20	1.3	175
7	NGRC02757	69.8	5.4	1.3	23.5	14	21	1.6	224
8	NGRC02758	83.7	5.9	1.5	38.3	15	22	1.9	257
9	NGRC02760	78.3	5.0	1.4	26.4	17	22	1.4	209
10	NGRC02761	104.7	7.1	2.0	38.2	14	22	1.7	154
11	Vikash	101.6	6.3	1.7	42.7	12	22	1.7	400
12	NGRC02762	74.7	6.1	1.5	24.5	14	22	1.4	223
13	NGRC02763	90.7	4.9	1.3	33.7	12	21	1.8	218
14	NGRC02764	66.8	4.4	1.6	5.27	16	22	1.7	185
15	NGRC02765	86.0	5.9	0.7	34.7	20	18	2.5	303
16	NGRC02766	79.7	5.5	1.0	27.9	16	23	2.2	147
17	NGRC02767	64.2	4.5	1.9	29.5	19	22	2.1	153
18	NGRC02768	74.5	5.3	1.6	24.8	17	23	2.1	170
19	NGRC02769	89.1	5.5	0.8	32.9	14	22	1.7	366
20	NGRC02770	81.3	5.0	1.5	28.6	16	20	2.3	274
21	NGRC02771	81.0	6.2	1.7	27.1	14	21	1.9	159
22	Pragati	82.6	5.0	1.4	33.7	11	22	2.2	386
23	NGRC02773	87.1	4.6	1.3	33.0	14	22	1.5	314
24	NGRC02775	98.9	4.9	1.2	32.9	17	22	1.5	412
25	NGRC02777	98.0	5.2	1.7	32.9	14	23	1.6	177
26	NGRC02779	84.6	5.0	1.6	31.5	12	21	1.8	210
27	NGRC02780	82.1	6.2	1.7	31.1	11	21	1.6	195
28	NGRC02781	90.2	6.3	1.8	27.8	14	23	1.4	195
29	NGRC02783	72.8	6.2	1.6	31.0	15	22	1.4	188
30	NGRC02785	81.7	5.6	1.5	32.5	14	23	1.8	113
31	NGRC02787	82.6	5.4	1.3	25.5	18	23	1.3	137
32	NGRC02746	78.2	6.6	1.2	28.3	16	23	1.8	254
33	Lumle tori	84.5	6.5	1.7	24.4	14	22	1.7	223
34	NGRC02747	85.1	5.5	1.5	31.9	17	23	1.5	221
35	NGRC02749	85.2	5.1	2.0	24.6	17	23	2.2	284
36	NGRC02790	80.3	6.7	1.7	25.8	16	21	1.7	175
37	NGRC02795	100.4	6.4	1.5	31.8	14	25	1.1	101
38	NGRC02797	74.4	5.1	1.3	26.1	14	21	2.0	203
39	NGRC02798	93.4	5.4	1.7	27.6	15	23	1.7	193
40	NGRC02801	94.2	5.3	1.6	31.4	11	22	1.2	144
41	NGRC02807	72.2	6.2	1.7	19.8	10	21	1.3	148
42	NGRC03860	84.2	5.8	1.4	28.2	10	23	1.3	150
43	NGRC04243	93.8	5.5	1.2	32.5	13	23	1.4	144
44	Unnati	90.0	5.4	1.0	30.3	12	24	1.7	281
45	Baltori	75.5	5.8	1.0	29.3	16	21	1.7	113
46	Preeti	92.7	5.0	1.5	29.3	16	25	1.8	241
47	Surkhet local 3	81.3	4.5	1.9	30.0	12	24	1.4	154
48	Morong tori	60.1	4.8	1.4	25.7	22	24	2.0	49
	Mean	**82.6**	**5.6**	**1.5**	**29.6**	**14.6**	**22.1**	**1.7**	**208**
	P value	***	**	***	***	***	***	***	***
	LSD(0.5)	**25.2**	**1.21**	**0.35**	**7.3**	**3.1**	**2**	**0.56**	**132.4**
	CV (%)	**1.52**	**15.6**	**22.4**	**19.5**	**20.5**	**7.7**	**25**	**4.9**

3.3 SEED VARIETY IDENTIFICATION USING DNA FINGER PRINTING TECHNOLOGY

Methodology of DNA extraction

Bulk DNA was extracted using the CTAB (Cetyltrimethylammonium bromide) method.

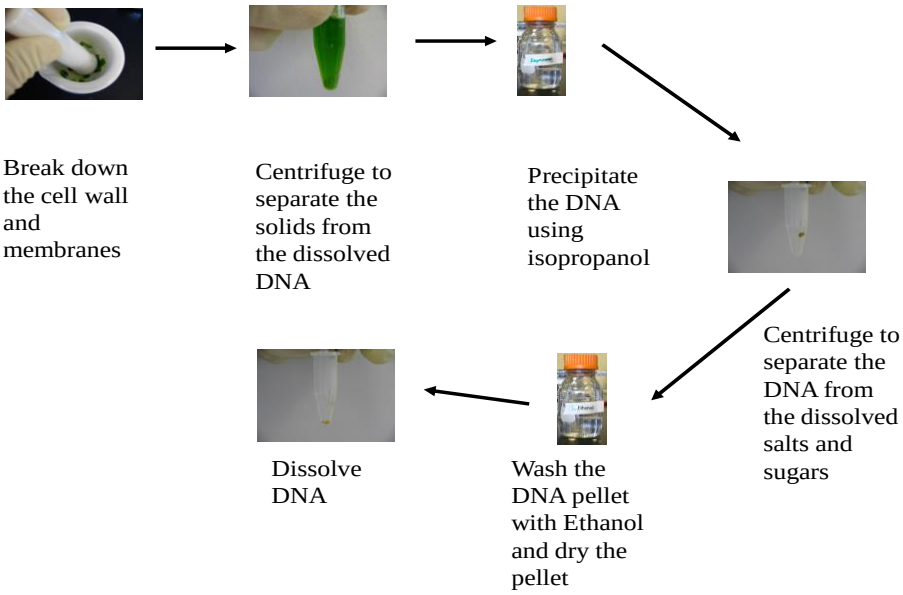


Fig. 5: Overview of DNA extraction

PCR Amplification

PCR was amplified under following conditions: 5 minutes of denaturation step at 94ºC followed by 35 cycles of 94ºC for 1 minutes, (52-61)ºC for 1 minutes and 72ºC for 1 minutes followed by a final extension at 72ºC for 5 minutes. Gel was visualized in UV gel documentation using 2.5% agarose gel.

3.3.1 DNA finger printing and diversity analysis of different released and promising genotypes of rice using Simple Sequence Repeat (SSR) markers

Rice (*Oryza sativa* L.) (2n=24) belongs to the family Graminae and subfamily Orazoidea is the staple food for one third world's population and occupies almost one-fifth to the total land area covered under cereals. Rice belonging to genus *Oryza* is an ideal model plant for the study of grass genetics and genome organization due to its diploid genetics, relatively small genome size of 430 Mb (Causse et al., 1994), significant level of genetic polymorphism (Mc Couch et al., 1998), large amount of well conserved genetically diverse material (about 100,000 accessions world wide) and the availability of widely collected compatible wild species. As rice is highly diversified

crop, assessment of genetic diversity is essential for further maintenance of varieties and pre-breeding program.

Genetic diversity can be evaluated with morphological traits, seed proteins, isozymes and DNA markers. The term molecular marker is taken to refer as markers for identifying variation at the level of DNA of individual organism. Molecular marker technology is the powerful tool for determining genetic variation in rice varieties. In contrast to morphological traits, molecular markers can reveal abundant difference among genotypes at the DNA level, providing a more direct, reliable and efficient tool for germplasm characterization, conservation, and management and not influenced by environment. SSR markers are more popular in rice because they are highly informative, mostly mono-locus, co-dominant, easily analyzed and cost effective (Prabakaran et al., 2010).

Objective:

The main oblective of this study was to accomplish DNA fingerprinting and genetic diversity analysis of different rice varieties to measure the extent of genotypic differences, genetic relationship and to assist in broadening the germplasm base for future rice breeding programs.

Materials and methods

Germplasm

A total of 87 rice samples including 36 released varieties were used for microsatellite analysis. Sample seeds were collected from National Rice Research Program (NRRP), Hardinath, Dhanusha. The details of rice genotypes and materials are presented in Table 13 and fig 6 and 7.

Table 13: List of rice varieties/genotypes used in DNA finger printing, NSSTRC.

Genotype code	Name of Variety	Genotype code	Name of Variety
1	IR15 L 1008	2	Chaite-6
3	PR 101	4	Radha-17
5	Sunaulo Sugandha	6	Pusa 834
7	BW 306-2 (BW 36-2)	8	Bindeshwari (Bindeswori)
9	Anmol masuli	10	Type-3
11	Sabitri	12	HHZ25-DT9-Y1-Y1
13	Bhotiya masuli (Bhootia.masuli)	14	Black Rice
15	Pusa.Basmati	16	Ghaiya-2
17	IR86515-19-1-2-1-1-1-1	18	Bandana
19	NR2170-1-1-1-4-1-1-1	20	Radha-9
21	Basmati Malaysia (Basmati Malaysia)	22	Pusa 509
23	Radha-11	24	Sarbati
25	Bahuguni-2	26	IR10353-8
27	Kachhi masuli (Kanchhi.masuli)	28	Basmati 307
29	Jaya	30	PR 126

Genotype code	Name of Variety	Genotype code	Name of Variety
31	Chananchur	32	Pant Basmati-2 (Display)
33	Radha-14	34	Janaki
35	Govind (Gobind)	36	DN-5-3-2
37	BR 35	38	Sambha masuli sub-1
39	IASSAR-16	40	Swarna
41	DR-11	42	Pusa-1509
43	IR 16L 1661	44	Sugandhit Dhan-1
45	Hardinath-1	46	NR2157-122-1-2-1-1-1
47	Morang Basmati	48	Rabun Saptari (Rabun Saptri)
49	Sukhadhan-4 (Sukha Dhan-4)	50	Hardinath-2
51	Kalonuniya	52	IR15D1075
53	Rampur masuli	54	Radha-13
55	IR13F 115	56	IR12F 578
57	IR77721-93-3-2	58	Hardinath-3
59	Chaite-2	60	Tarhara-1
61	Sukhadhan-3	62	Deutaeora (Dejgora)
63	Kachorwa	64	CNTLR 90333
65	Bans.dhan	66	Katarni
67	Bahuguni-1	68	Kalanamak
69	CH 45	70	Mithila
71	DN-5-3-3	72	Jhapali masuli
73	Bakhe 3004 (Barkhe-3004)	74	Makawanpur-1
75	Pant dhan-1	76	Ramdhan
77	Radha-12	78	Chaite-5
79	Hardinath-3	81	Sukha dhan-5
82	Pant Basmat-2	83	Sukha dhan-1
84	Sona masuli	85	Sukha dhan-6
86	Lalkha Basmati	87	Swarn sub-1

Leaf material collection and DNA extraction

Sample seeds were placed in plastic trays containing soil and germinated in seed germinator. Young and healthy leaves (2-3 cm long) from 12-21 days old seedlings were harvested. Total genomic DNA from the leaf samples was extracted following Cetyl-Trimethyl-Ammonium bromide (CTAB) based protocol described by Murray and Thompson (1980) with modification. The DNA extract in the form of pellet was suspended in 50µl of TE buffer and prepared 10% working DNA solution with deionized water. The extracts were stored at -20^{0}C.

SSR marker genotyping

A set of 15 SSR primer pairs (Chakravarthi et al., 2006) were used. PCR reactions were conducted in a reaction volume of 15 µl, using 2 µl of template DNA with 7.5 µl of master mixture, 1.5 µl of each reverse and forward primers and 2.5 µl of sterile water. The PCR plates were placed in a thermal cycler machine for amplification of target DNA fragments and was programmed with condition of: initial denaturation at 95^{0}C for 5 min; 35 cycles of 1 min at 94^{0}C, annealing at 54-58^{0}C for 1 min, 2 min at 72^{0}C; and plus a

final extension step at 72^0C for 7 min. In the thermal cycler, annealing temperature was set up appropriate for each primer pairs to ensure successful amplification.

Determination of microsatellite allele lengths

SSR-PCR products were analyzed on 2.5% agarose gel, visualized by staining with ethidium bromide under short-wave UV light. 100 bp DNA ladder was used in the electrophoresis.

Data analysis

The polymorphism percentage was calculated with different primers based on the banding pattern obtained. The presence of each informative band was measured, while its absence was scored as zero. The polymorphic information content was calculated using the formula: $PIC=1-\Sigma(P_i)^2$, where, 'P_i' is the frequency of the i^{th} allele calculated for each microsatellite locus.

Results and discussion

In present study, 15 SSR primers distributed from chromosome 7 to 12 were used to estimate genetic diversity among 86 genotypes. All 86 rice cultivars were successfully amplified with the 15 microsatellite primer pairs. A total of 1167 alleles were detected among all genotypes. The number of alleles per locus varied from 15.6 to 56. Banding patterns generated by primer pairs RM-21, RM-547 and RM-222 in various rice cultivars are shown in Fig 6 (A), Fig 6 (B), Fig 7 (C) and Fig 7 (D).

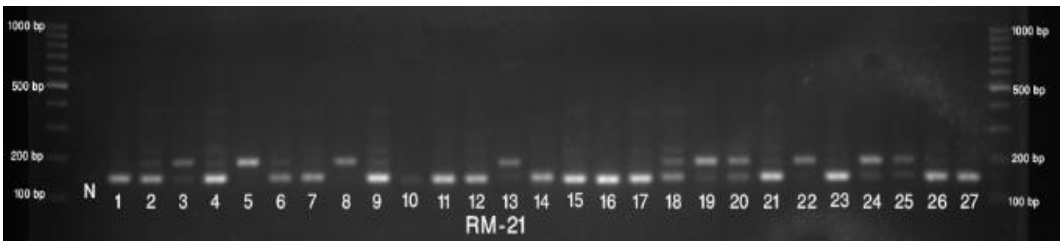


Fig 6 (A)

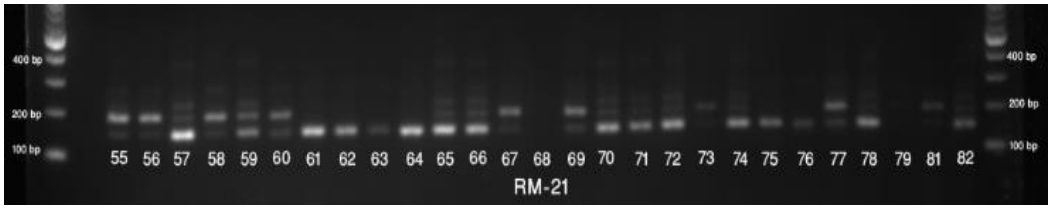


Fig 6 (B)

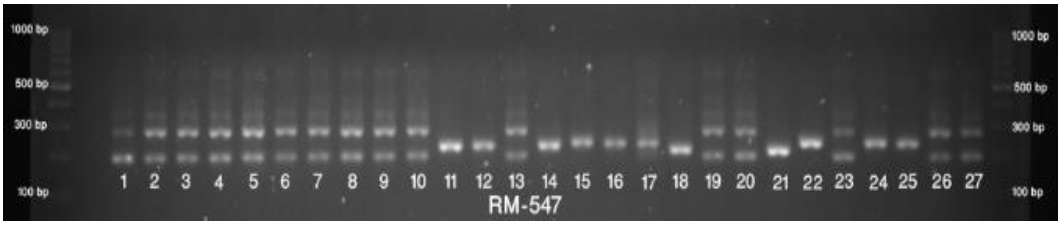


Fig 7 (C)

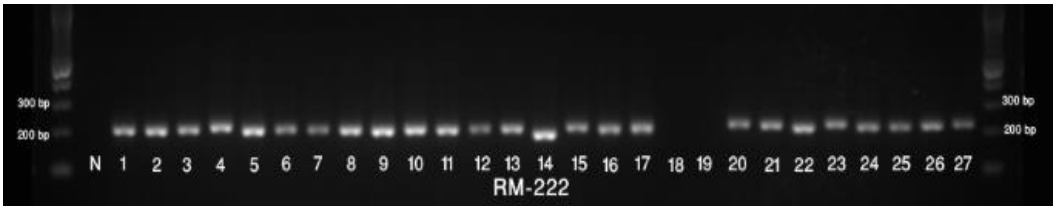


Fig 7 (D)

Fig 6 and Fig 7: Amplification profiles of various rice (Oryza spp.) cultivars at the locus RM-21 (6A, 6B) and RM-547 (7C) and RM-222 (7D); L, Molecular wt. marker (100 bp ladder)

In the current studies, 13 out of 15 SSR primer pairs generated polymorphic bands. PIC values for SSR ranged from 0.03 to 0.73 with mean value of 0.44. The highest PIC value was observed with primer RM-320. The detail demonstration of the diversity analysis of rice genotypes using SSR markers are presented in Table14 and Table 15.

Table 14: Analysis of DNA profiling (finger printing)/genetic diversity among various rice varieties/genotypes

S.N.	Primer code	Chromosome location	Molecular wt. range (bp)	Total no. of alleles	No. of polymorphic alleles	Alleles per locus	Polymorphism information content (PIC)
1	RM-21	11	100-200bp	112	2	56	0.03
2	RM-536	11	200-300bp	-	-	-	-
3	RM-566	9	200-300bp	82	3	27.33	0.36
4	RM-206	11	100-200bp	86	4	21.5	0.66
5	RM-320	7	100-300bp	78	5	15.6	0.73
6	RM-247	12	100-200bp	83	2	41.5	0.11
7	RM-544	8	200-300bp	-	-	-	-
8	RM-346	7	100-200bp	87	3	29	0.57
9	RM-547	8	150-300bp	131	4	32.75	0.3
10	RM-519	12	100-200bp	85	3	28.33	0.35
11	RM-286	11	100-200bp	86	4	21.5	0.48
12	RM-561	-	100-200bp	86	3	28.67	0.59
13	RM-222	10	200-300bp	83	3	27.67	0.56
14	RM-47	7	200-300bp	85	2	42.5	0.5
15	RM-10	7	100-200bp	83	2	41.5	0.48
				Total alleles = 1167	**Total polymorphic alleles = 40**	**Ave. alleles per locus = 31.83**	**Mean value of PIC = 0.44**

Table 15: Diversity parameters among the rice varieties/genotypes

Total sample analyzed	86
Total SSR markers tested	15
Total SSR markers amplified	15
Total polymorphic marker	13
Total monomorphic marker	2
% of polymorphic loci (marker)	86.67%
Total no. of alleles	1167
Average alleles per locus (marker)	31.83
Total no. of polymorphic alleles	40
Allele per polymorphic loci	3.08

The result indicated that the SSR markers are neutral and co-dominant and could be a powerful tool to assess the genetic variability of the cultivars. The information about the genetic diversity will be very useful for proper identification and selection of appropriate parents for breeding programs, including gene mapping, and ultimately for emphasizing the importance of marker-assisted selection (MAS) in rice improvement worldwide. With the aid of microsatellite markers, different distantly related rice genotypes may be combined by intercrossing genotypes, for instance, aromatic rice genotypes with non-aromatic rice genotypes from different clusters to get hybrid varieties with highest heterosis (Sajib et al., 2012). Markers with PIC values of 0.5 or higher are highly informative for genetic diversity studies and can be successfully used to distinguish the polymorphism at a specific locus.

3.4 PARTICIPATORY TECHNOLOGY VERIFICATION AND DISSEMINATION

3.4.1 Study of seed setting in hybrid rice seed production by using different male to female ratio

Introduction:

Rice (*Oryza sativa L.*) is the major food crop among the cereals in Nepal. It is grown from low land to high land Chhum chaur Jumla district. Rice is consumed by about 3 billion people and is the most common staple food of a large number of people on earth. It is cultivated on 1.55 million ha of land with a production of 5.23 million tons and productivity of 3.36 t/ha (MoAD, 2017/18). Inbred rice varieties has been cultivated across the country. The area of inbred rice varieties has been declining day by day due to introduction of multinational company hybrids. Recently NRRP has developed Hardinath hybrid rice varieties and their parental lines are using to produce hybrid rice seed by different seed companies.

Objectives:

- To find out the exact A:R ratio in hybrid rice seed production.
- To study the exact synchronization flowering between A and R lines by using GA3.

Materials and methods

This experiment was conducted in collaboration with National Rice Research Program (NRRP), Hardinaath, Janakpur during summer season 2077. Lines were received from NRRP. Experiment was conducted in RCBD with three replications and four treatments. Treatments were (1) two rows male: six rows female (A), (2) two rows male: eight rows female (A), (3) two rows male: ten rows female (A) and (4) two rows male: twelve rows female (A). Other practices were followed as per protocol developed by NRRP.

Results and discussion

Average mean was estimated from data of three replications. Significant variation was not observed in all the variables. Result of grain yield showed that 2:12 (3587kg/ha) and 2:6 (3300kg/ha) produced relatively higher grain yield over to grain yield of 2:10 (3160kg/ha) and 2:8 (2240 kg/ha). Ratio 2:8 produced low grain yield compared to ratio 2:6. The reason behind it could be low thousand grain weight. We have identified approximate heading time of both male parent (R line) and female parent (A, CMS line). Based on the difference of flowering time of these two parents, the seeding time variation for restorer (R) has been determined. In the context of Hardinath Hybrid-1, seeding pattern of CMS and R line is constructed where two split seeding of R line is recommended. First date of seeding for R line is two days after the CMS line seeding. Similarly second date seeding for R has been planned for 5 days after the CMS seeding. It has reflected that the Restorer line is somehow earlier in maturity than CMS line. It also depends on the season of year and varies according to temperature and light conditions. In one season the heading/flowering time synchronizes, it is not necessarily to synchronize the heading time of both parents on the same pattern of seeding time. It indicates that the flowering time variation does not exceed for 7-8 based on the recommended seeding time of these parents. When the flowering time run out, we have also other option to manipulate the synchronized heading by applying the GA3 when the maturity is delayed on the parents. The main objective of GA3 application is to expedite the flowering. We can accelerate 3-5 days of flowering of either parent which is being delayed. It must be applied for 2-3 times depending upon the situation until the maturity synchronized and pollination is achieved. The pollination is carried out by ropes drawn by persons on the both ends. In the normal heading condition in both parents, GA3 is uniformly applied on the both parents when the panicles exert open. Another two doses of GA3 is repeated for restorer (R) to extend the flowering time and pollen load on the male parent. It also supports to increase the height of plant to facilitate the pollination or

pollen shedding. Quantitative data regarding 50% heading days of both male and female and days to 80 % maturity of female, plant height(cm), Panicle length(cm), average number of effective tiller/ hill, fertility%, TGW(g), straw yield t/ha and grain yield was calculated by using the formula as GY kg/ha= ?. Data were analyzed by using Gene stat. Detail results are presented in table 16.

Table 16: Performance of different male: female ratio in hybrid rice seed production

Trt. No.	Planting Ratio (Male: Female	Days to 50% Heading	Plant Height (cm)	Panicle Length (cm)	Tiller no.	Filled Grain /panicle	Grain Yield kg/ha	TGW (g)
1	2:6	96.7	96.7	27.3	52.7	113	3300	21.4
2	2:8	94.0	91.0	28	53.3	128	2240	20.8
3	2:10	93.7	92.3	28	53.3	124	3160	20.9
4	2:12	95.7	92.3	27.7	54	100	3587	22.1

3.4.2 Study of seed setting in hybrid maize seed production by using different male female ratio

Introduction

Maize (*Zea mays* L.) is the second most important staple food crop after rice but accounts first in mid hills of Nepal. It is cultivated on 956447 ha of land with production and productivity of 2713635 mt and 2.84 t/ha in respectively in the country. It is grown from low land to high hills. Among total cultivated area 72.3% area falls under mid hills. It is grown during summer season in mid and high hills, winter season in terai, and spring season in inner terai and river basin areas. Open Pollinated Varieties (OPVs) are popular in mid and high hills. Very few numbers of farmers grow the Quality Protein Maize (QPM) in mid hills. Hybrid varieties are grown in terai, some part of mid hills and river basin areas. Now a days hybrid variety are becoming popular among the farmers of terai and lower part of mid hills, valleys and river basin areas. NSSTRC conducted experiment on different male female ratio of Rampur hybrid -10 to achieve the following objectives.

Objectives:

- To identify the perfect nicking between male and female.
- To identify the best male female ratio for good seed setting.
- To improve the quality and increase the quantity of hybrid seed.

Materials and methods

Maize hybrid seed production was conducted in collaboration with farmer's groups and Prime Minister Agriculture Modernization Project (PMAMP), Dang district. Maize hybrid seed production site (Deukhuri) was selected based on advice of PMAMP. Trial

was conducted in RCB design in three replications with Male1row:female3rows, Male 1 row: female 4 rows, Male 1 row: Female 5 rows, Male 2 rows: Female 4 rows, Male 2 rows: Female 5 rows, Male 2 rows: Female 6 rows and Male 2 rows: Female 8 rows. Plot size was ranged from $45m^2$ to $112.5m^2$. Grain yield will be recorded from net harvested area. Male rows seeded 3 days before seeding to female rows where one male row was fixed. All female rows were seeded after 3 days of male planting. In case of two male rows staggered planting (3 days interval) was done and all female rows were seeded after three days of first and second male planting. Row to row spacing was 75cm for both male and female whereas plant to plant space was 20cm for female planting and 15 cm for male planting. Recommended dose of chemical fertilizers was 120:60:40 kg N:P:K kg/ha and compost/FYM was 10t/ha. All FYM, DAP and MoP were used as basal dose and urea was used in two split doses during knee height stage and booting stage. Male rows and female rows were marked with colorful pegs. All the tassel were removed (detasseling) from female rows before pollen shedding. Every day careful detasseling was done to maintain genetic purity of seed. After the end of pollen shedding, all male rows were removed to avoid genetic contamination during harvesting, threshing etc. Data were recorded of 50% male rows tasseling and 50% female rows silking. Other data including grain yield were not recorded due to long luckdown, COVID-19. Some data were recorded by farmers but those data were not reliable and could deliver wrong message.

4. TECHNOLOGY TRANSFER AND SERVICES

4.1 Services

NSSTRC has been working in close association with crop breeding and national commodity programmes, private seed companies, agricultural cooperatives, seed production projects /programs and provides the seed testing and information services to respective seed stakeholders. Followings were the seed quality attributes tested in Central seed laboratory following ISTA 2011 rules and guidelines as well as norms developed by NSB. Seed analysis reports were provided to respective seed producers, seed companies, researchers and farming groups. A total of 438 seed samples were analyzed and reported, out of which 219 samples were service samples and 229 samples were research sample (Annex 4.2). Seed testing services focused on:

- Analytical Purity Analysis, Moisture Content Test and Germination test (Routine Seed Test)
- Tetrazolium Salt Test, Vigor Test, Ageing Test, Cold Test, Field plot and biochemical and molecular marker test (special testing)
- Proficiency seed sample testing

4.2 Publications

In 2076/77, two publications were prepared, of which one is "Annual Report, 2076/77" and another is leaflet entitled on "Introduction to Seed Science and Technology Division" in both English and Nepali in order to disseminate the latest technological output and status of National Seed Science Technology Research Centre. (Annex 4.3).

4.3 Visits

Scientists, professors, technicians, students etc. were visited to have technical information and facilities of NSSTRC with regard to the seed quality testing services. Students, agriculture extension staffs of DoA, also visited the NSSTRC laboratory (Annex 4.4).

5. BUDGETAND EXPENDITURE

Total NSSTRC project and office administration cost for the year approved and released was NRs 1,33,76,000/-. Out of total budget, only NRs 1,19,31,973/- was expended (Annex 12). During the year, total revenue of NRs 1,66,846/- was collected through seed testing services and sales of research crop production and others (Annex 13). Total beruju was NRs 84,225/- during 2076/77 (Annex 14).

6. KEY PROBLEMS

Limited laboratory space is still the key problems in the centre. The centre has been successful in facilitating and strengthening the service and research resources with support of collaborative seed projects, however, due to the limitation of space in the building they could not have been brought into full operation. For the limitation of the space, NSSTRC would suggest to allocate whole building and premises for NSSTRC as 'Seed Bhawan'. Another important problem is lack of scientific manpower to run the molecular lab and seed lab.

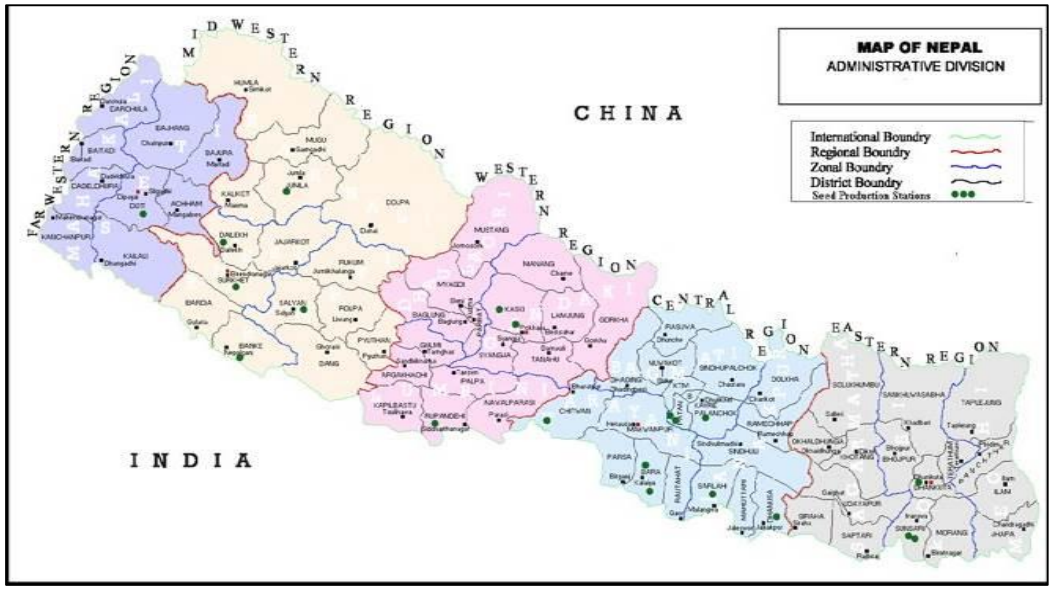
7. WAY FORWARD

A good amount of research in the field of National Seed Science Technology Research Centre has been carried out and significant contributions made on seed regulatory frameworks formulation and implementation in past and recent year by the centre. The field is wide as it includes a cadre of disciplines of seed biology to its marketing, management and uses. But in the present context following research areas on quality seeds for improving the production per unit area are felt to prioritize and carry out the studies:

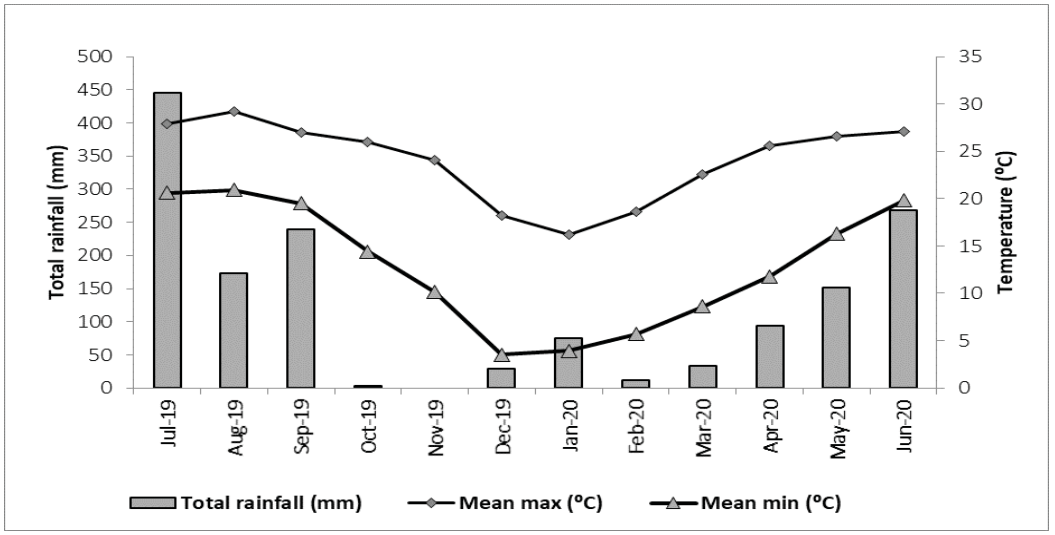
- Basic studies on seed biology, morphology, and physiology of different agricultural crop species.
- Resiliency of seeds to climate change
- On-farm seed management and improvement of farmers saved seeds which dominates the national seed system
- Use of biotechnology and molecular techniques in support of seed technology and genetic studies of local crop diversity
- Collaborative research with different seed stakeholders
- Harmonizing the seed quality and their use
- Seed production research in hybrid maize and rice

ANNEXES

Annex 1. Map of the seed production stations, NARC

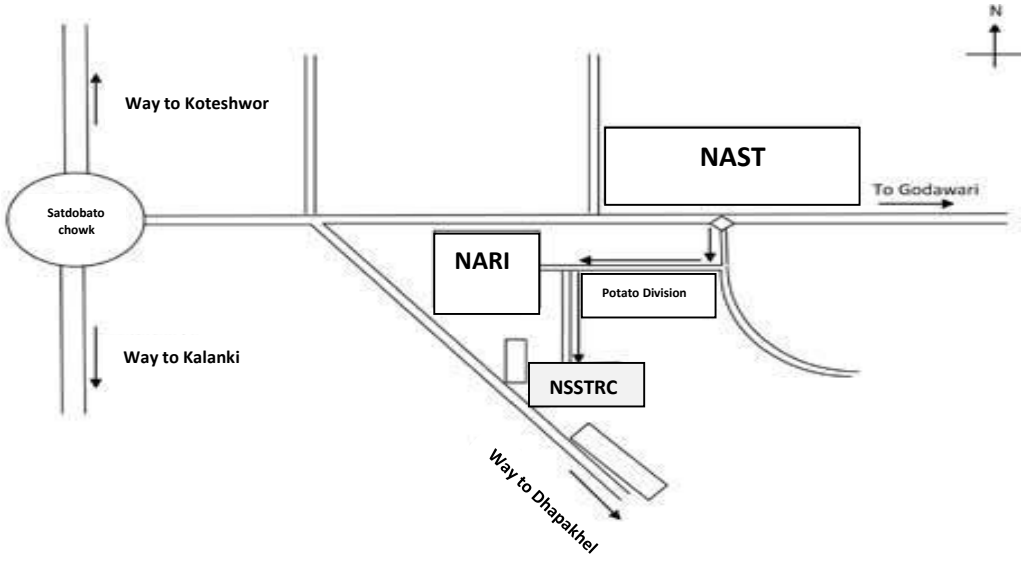


Annex 2. Monthly agro-meteorological data, Khumaltar, 2076/77 (2019/20)



During this fiscal year, Khumaltar received 1525 mm annual rainfall in 147 rainy days with annual average of maximum and minimum temperature 25.9ºC and 12.93ºC, respectively.

Annex 3. Map of the office/station



Annex 4.1. List of seed testing laboratory facilities, NSSTRC, Khumaltar in 2076/77 (2019/20)

S.N.	Major instruments	Testing facilities
1	Ag seed magnifier *(W/light seed, Buro Ag-MC110/c)*	Magnifying seed
2	Air conditioner *(Chunlan)*	Maintaining temperature inside working room
3	Altimeter *(Multi-function digital altimeter, Model no. ZD-2028/ 6 in 1)*	Recording altitude of location during seed sampling
4	Balance *(Electric balance, Triple beam balance, Pan balance, Torsion balance, Digital counting balance/ Weighing scale, Electronic kitchen scale, Denver instrument-counting balance, 4-digit balance-Kern ABJ, 3-digit balance, Electronic balance of 100 kg capacity)*	Working sample preparation and seed weighing
5	Camera canon DSLR	Capturing photos of lab and field activities
6	Canon 3010 *(3 in 1 printer)*	Printing reports and protocols
7	Check point of O_2/Co_2 recharge adapter	Measuring O_2 and CO_2 of sample
8	Chlorophyll meter *(TYS-A and spad 502)*	Recording chlorophyll content of leaf
9	Computerized seed counter	Seed counting
10	Corn Thresher *(electric)*	Threshing corn
11	Dan sensor O_2 and CO_2 gas analyzer	Gas analysis
12	Desiccators *(Big size, medium size and small size)*	Sample storage for short period
13	Desktop Computer sets *(Goldkist, Lenovo, Acer)*	Data recording and technical works
14	Dickey John *(Grain Analyser Computerised Moisture Meter)*	Recording Moisture content of sample
15	Digital Calliper	Seed measurement unit (mm)
16	Digital Camera *(Canon, Sony, Cyber-shot 14.1 mega pixels, Carl Zeiss, Vario-Tessar)*	Capturing laboratory activities
17	Digital temperature and RH indicator	Recording Temperature and RH
18	Digital thermo hygrometer	Temperature and RH reading
19	Digital vernier caliper DL.S1 Lutron	Quantitative trait reading
20	Divider *(Boerner Seed Divider, Soil Seed Divider, Gamet Seed Divider)*	Working sample preparation
21	E.Q.F Disintegrator high speed mill *(24000 RPM, 100 GFW100)*	Seed milling
22	Eye piece-digital camera (*Coslab- MDCE-5C)*	Microscopic photography
23	Fax machine	Faxing documents
24	Fiber Measuring tape *(Field tape)*	Recording measurements of field
25	Filing cabinet *(steel and glass door cabinets)*	Record filing
26	Gas Air Quality Meter *(CO_2, O_2, CO, RH, 42 Temp 6 in 1)*	Gas analysis meter
27	Glass plate	Purity analysis
28	GPS- *GARMIN (e-Trex Legend H & Vista H, Rugged and high sensitivity GPS)*	Measurement of altitudes and others
29	Grain density meter *(Phoenix instrument)*	Weighing sample
30	Hand scoop SS large	Withdrawing samples

S.N.	Major instruments	Testing facilities
31	Hanna EC meter *(meters for EC/ TDS/OC/OF)*	Conductivity test
32	High Speed Grinder	Grinding sample
33	Hygrometer *(Tem./Clock/Humidity)*	RH /T measurement
34	Laboratory aspirator	Purity
35	Laptops *(Acer, Lenovo, Dell, slim laptop - dell)*	Data recording, analysis and report writing
36	Microscope *(Leitz-HM-LUX-3, Wild M3Z- Heerbrugs Switzerland, Olympus SZ51, Leitz-Laborluz K)*	Seed identification and seed micro- organism infection
37	Mini Tiller	Ploughing the research field
38	Mobile set *(Huawei and Redmi)*	Communicating devices
39	Oven *(Memmert (small and big), Electric Baking Oven)*	Moisture testing and drying beads
40	Paddy Thresher Machine *(Manual)*	Threshing rice
41	pH meter *(Portable)*	Recording pH of sample
42	Photocopy machine *(Canon-iR 1024)*	Photocopy and scanner
43	Plant growth chamber	Germination
44	Portable leaf area meter	Recording leaf area
45	Portable Sieve Set	Sieving
46	Projector *(Optima)*	Presentation of files
47	Refrigerator *(lg)*	Storing chemicals and reagents
48	Sample Trier set	Sampling unit
49	Samsung Tab A 8.0	Recording data and sharing information
50	Sealing Machine *(Vacuum sealer & Impulse sealer)*	Relative to post- harvest study
51	Seed ageing chamber *(10 cu ft. All stainless steel accumax India)*	Vigor test
52	Seed Aging Chamber	Vigor test
53	Seed analyzer with scanner	Seed analysis
54	Seed blower Dacota type	Blowing samples
55	Seed coating machine	Sample coating
56	Seed Enlarger seed Buro	Magnifying objects
57	Seed Germinator *(Labline Technocracy, Indosaw, Accumax)*	Germination of sample
58	Seed Grinder *(Rico and Victor)*	Seed moisture content
59	Seed grinder Lab mill *(3310 perten S/N 160611)*	Seed grinding
60	Seed Moisture Meter Wile 78 Crusher-7	Moisture test
61	Seed Purity Board	Seed purity
62	Seed sampler *(30 inches X 5 holes)*	Seed sampling
63	Seed sampling tier *(20 mm brass, light and heavy)*	Seed sampling
64	Seed scoop	Seed lifting
65	Sieve set (*B.B. Allauf mfg.co.inc. Washington D.C, 75mm / 20 sieves set)*	Sampling unit
66	Single ear thresher	Threshing
67	Single panicle/headthresher-1	Threshing
68	Soil Auger *(Screw type-98 mm)*	Soil sampler
69	Soil moisture meter	Soil moisture test
70	Stabilizer and Voltage Regulator *(Stavol-matsunaga, Powertech- 3KVA, Powertech-2 KVA,*	Power supply to sensitive machinery and digital balance

S.N.	Major instruments	Testing facilities
	Premier Servo motor control PS 2000 VA and 1500VA)	
71	Steel cupboard *(plain and locker type)*	Storing record files and registers
72	The pHep Family Hanna Instrument *(Min./Max. temp. record)*	Seed conductivity test
73	Thermometer *(Manual)*	Calibration of germinators
74	UPS *(Sukam, Emerson)*	Backup for computer
75	Vacuum seed counter	Seed counting
76	Water pump *(Crompton Greaves)*	Water supply
77	Wile-66	Portable grain moisture test
78	Xerox Canon MF 3010 set *(3 in one)*	Printing and scanning
79	ZH 3500 Generator	Power supply

Annex 4.2 List of Molecular Laboratory Facilities, NSSTRC, Khumaltar, 2076/77 (2019/20)

S.N.	Major Instruments	Testing facilities
1	Air Conditioner *(Panasonic)*	Cooling lab
2	Animax Real Time PCR *(PC system, Power backup solar Hybrid - 3 pieces)*	DNA Finger printing and backup system
3	Autoclave *(Accumax, India)*	Sterilization unit
4	Centrifuge *(REMI, CAT No. R-24, Serial no.-VCDP-5338)*	Homogenizing unit
5	Deep fridge *(Whirlpool and Yasuda)*	Preserving the DNAs
6	Desktop Computer set *(HP Pavilion and Acer)*	Data entry and analysis
7	Electrophoresis *(power supply - Serial no.93086, EV 243, Made in Belgium and Multi sub midi set 10 X 10 cm*)	Supply of power and gel electrophoresis unit
8	Gel documentation *(Alpha Innotech)*	Documenting the banding of DNAs on gel
9	Ice box	Cooling DNA samples
10	Ice flack machine-*SIMAG*	For making Ice Flakes
11	Incubator Machine *(Water bath)-18X18X18)*	Incubation
12	Laminar flow	Health test
13	Liquid Nitrogen Refrri	Storing liquid nitrogen
14	Magnetic stirrer *(SONAR, CAT No. MS-1, Serial no. F0034910311)*	Shaking and mixing unit
15	Medifuge *(Heraeus Sepatech RPM X 1000)*	Homogenizing unit
16	Micro Oven *(lg- ECN.MS-2344BB/01, Serial no. 803TAUL 00070)*	Preparing gel
17	Micro-centrifuge *(PPW Med. Instrument, Model no. MPW-55, Ref no. 10055)*	Homogenizing unit
18	pH meter *(Chemi line, Digital PH meter with ATC CL-120*)	Determining PH
19	Polymerase Chain Reaction *(PCR - Corbet, Model no. CGL-96, Serial no. C-10081)*	DNA sequence amplification unit
20	Refrigerated micro centrifuge *(Model T 50)*	Homogenizing unit
21	Spectrophotometer *(JENWAY, Model no. 6705, Serial no. 3651-single cell holder)*	Quantification of DNAs
22	Vaccine carrier *(1.6 liter w/4 Ice packs Aov)*	Cooling
23	Vitascope *(Burrows equipment co., Evanston, Illionis, USA,*	X-rays of seed and Florets

S.N.	Major Instruments	Testing facilities
	Serial no. S104)	
24	Vortex mixer *(Accumax- Touch type and Tallboys USA-digital)*	Shaking the solns
25	Water bath *(SONAR)*	Warming the PCR Recipes
26	Water Distillation Unit *(Single distillation unit-accumax and Double distillation unit-biobase)*	Making distilled water

Annex 5 Human resource in 2076/77 (2019/20)

S.No	Name	Position	Qualification	Specialization/Working area
1	Tara Bahadur Ghimire	S_5	PhD.	Agronomy
2	Sangita Kaduwal	S_1	M Sc. Ag.	Agronomy
3	Gopal Bhandari	T_6	M Sc. Ag.	Agronomy
4	Devi Kumari Dhakal	A_6	BA	Administration
5	Sunil Shrestha	A_5	MBS	Accounting and Tax
6	Pragnya Pokharel	T_5	B.Sc Ag	Agricultural Economics
7	Goma Bajgain	Technical Assistant (Fifth Level)	Literate	Lab Assistant
8	Bishnu Maharjan	Technical Assistant	Literate	Lab Assistant
9	Lahani Tharuni	Technical Assistant	Literate	Lab Assistant
10	Madan Man Dangol	Driver	Literate	Driving

Annex 6 Summary progress of research projects in FY 2076/77 (2019/20)

PN	Name of project/activity	Project/ Activity leader	Budged allocated for this year	Major progress/achievements
982	**Technology generation for quality seed production in cereals**	**S Kaduwal**	**374**	• Significance difference observed in stage factors, plant height, number of spikelet/spike and sterility percentage. No significance difference among the micro nutrients factor except number of spikelet/spike. • Significance difference observed in plant height when applied Mn, Zn and Bo. Similarly, high sterility found in control and lowest sterility when applied combination of Fe+Mn+Zn=Cu+Bo. • There was no significant difference of defoliation, stage of defoliation and their interaction in phenological traits and other agronomical traits. • Significant difference was observed in SPAD reading at 60 DAS where highest SPAD reading was recorded in 50% leaf removal below the ear and lowest in control. • In study of seed setting in hybrid maize seed production by using different male/female ratio 1:3, 1:4, 1:5, 2:4, 2:5, 2:6, 2:8 were studied but trail was not
1	Effect of foliar application of micronutrients on seed quality and productivity of wheat			
2	Effect of defoliation on yield components and grain quality of maize			

PN	Name of project/activity	Project/ Activity leader	Budged allocated for this year	Major progress/achievements
				harvest due to more than one month long lockdown.
173	**Qualitative and quantitative characterization of pre-released varieties of agricultural crops**	**TB Ghimire**	**495**	• Descriptors of 7 hill genotypes of rice (NR-11115, NR-11139, NR-10676, NR-11011, NR11105, 08 FAN10 and Khumal-4) prepared. • Descriptors of 12 genotypes of wheat genotypes (WK-2257, WK-2430, WK-2432, WK-2551, WK 2748, WK 3026, WK-2602, WK-2669, WK-2777, WK-3025, WK 3027 and WK-1204) prepared. • Descriptors of 48 local genotypes including Vikash, Pragati, Lumle Tori, Unnati, Bal tori, Preeti, Surkhet local 3 and Morang tori of rapeseed (toria) prepared. • Descriptors of 9 varieties/ genotypes of finger millet (Dalle 1, Okhle 1, KLE 159, Kabre kodo 1, KLE 236, Sailung kodo 1, KLE 158, Kabre kodo 2) prepared.
1	Agro morphological characteristics study of hill varieties of rice	S.Kaduwal		
2	Agro morphological characteristics study of wheat	S.Kaduwal		
3	Agro morphological characteristic study of Finger millet	TB Ghimire		
4	Agro morphological characteristics study of rapeseed	TB Ghimire		
248	**Seed variety identification and diversity analysis using DNA fingerprinting technology**	**G Bhandari**	**846**	• DNA finger prints of 87 rice genotypes prepared by using 15 different SSR marker.
1	Assessment Conservation and DNA profiling (fingerprinting) diversity study of some common rice genotypes/varieties (inbred and hybrid).	G Bhandari		
193	**Improving hybridization efficiency and seed set in rice hybrid seed production**	**TB Ghimire**	**702**	• In hybrid rice seed production of different A and R ratio of 2:6, 2:8, 2:10, 2:12 were studied. Result of grain yield showed that 2:12 (3.59 t/ha) and 2:6 (3.30 t/ha) produced relatively higher grain yield.
1	Identification of optimum seed parent :Pollen parent row ratio			
2	Assessment of optimum time and season for heading and flowering			
235	**Participatory technology verification and dissemination on quality seed**	**TB Ghimire**	**570**	• In study of seed setting in hybrid maize seed production by using different male/female ratio 1:3, 1:4, 1:5, 2:4, 2:5, 2:6, 2:8 were studied but trail was not harvest due to more than one month long lockdown.
1	Maize hybrid seed production technology verification in mid hills and terai with PPP model	TB Ghimire		
251	**Farm Management Project (FMP)**	**Chief**	**1858**	• 219 seed service samples and 229 seed research samples were tested. • Repair and maintenance, farm security, beautification etc. carried out.
1	Seed Test and lab management			
2	Office and farm management			

Annex 7 Training/workshop/seminar organized in FY 2076/77 (2019/20)

SN	Name of Training/ Workshop/ Seminar	Duration	Target group	Location	No. of participants
1	None	None	None	None	None

Annex 8.1 Services provided (research sample), FY 2076/77 (2019/20)

Lab No	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)
0001	Farmer, Chandragiri 10	Wheat	Gautam	IS		99	0.0
0002	BKSS, Kavre	Wheat	WK 1204	IS	97	99.9	8.4
0003	BKSS, Kavre	Wheat	WK 1204	IS	98	99.8	8.3
0006	RARS, Tahara	Wheat	Bijaya	FS	83	0	10.8
0007	RARS, Tahara	Wheat	Tilotamma	FS	78	0	11.7
0008	RARS, Tahara	Wheat	Gautam	FS	85	0	10.6
0009	NRRP, Hardinath	Wheat	NL 971	FS	96	0	10.4
0010	NRRP, Hardinath	Wheat	Tilotamma	FS	91	0	10.5
0011	NRRP, Hardinath	Wheat	Bijaya	FS	94	0	9.9
0012	NRRP, Hardinath	Wheat	Gautam	FS	94	0	10.2
0013	Uddav Humagain	Wheat	WK 1204	IS	93	0	11.1
0014	Uddav Humagain	Wheat	WK 1204	IS	94	0	10.9
0015	Uddav Humagain	Wheat	WK 1204	IS	95	0	10.9
0016	Uddav Humagain	Wheat	WK 1204	IS	95	0	10.3
0017	Uddav Humagain	Wheat	WK 1204	IS	97	0	10.1
0018	Uddav Humagain	Wheat	WK 1204	IS	98	0	10.3
0019	Uddav Humagain	Wheat	WK 1204	IS	95	0	10.4
0020	Uddav Humagain	Wheat	WK 1204	IS	97	0	10.4
0021	Uddav Humagain	Wheat	WK 1204	IS	96	0	10.5
0022	Uddav Humagain	Wheat	WK 1204	IS	97	0	10.3
0023	Uddav Humagain	Wheat	WK 1204	IS	97	0	9.9
0024	Uddav Humagain	Wheat	WK 1204	IS	95	0	10.1
0025	Uddav Humagain	Wheat	WK 1204	IS	96	0	10.7
0026	Uddav Humagain	Wheat	WK 1204	IS	94	0	10.9
0027	Uddav Humagain	Wheat	WK 1204	IS	95	0	10.2
0028	Uddav Humagain	Wheat	WK 1204	IS	96	0	9.6
0029	Uddav Humagain	Wheat	WK 1204	IS	96	0	9.8
0030	Uddav Humagain	Wheat	WK 1204	IS	97	0	10.1
0031	Uddav Humagain	Wheat	WK 1204	IS	93	0	10.4
0032	Uddav Humagain	Wheat	WK 1204	IS	84	0	10.3
0033	Uddav Humagain	Wheat	WK 1204	IS	91	0	0.0
0034	Uddav Humagain	Wheat	WK 1204	IS	94	0	10.3
0035	Uddav Humagain	Lentil	Black Lentil	IS	92	0	8.1
0036	DNA Finger print	Rice	Garima "A"	HS	82	0	0.0
0037	DNA Finger print	Rice	Garima "B"	HS	82	0	0.0
0038	NWRP, Bhairahawa	Wheat	Dhaulagiri	BS	98	0	10.9
0039	NWRP, Bhairahawa	Wheat	Swrgadwari	BS	97	0	10.6
0040	NWRP, Bhairahawa	Wheat	Bijaya	BS	96	0	11.5
0041	NWRP, Bhairahawa	Wheat	NL 971	BS	97	0	11.3
0042	NWRP, Bhairahawa	Wheat	Aditya	BS	96	0	11.6
0043	NWRP, Bhairahawa	Wheat	Banganga	BS	98	0	11.2
0044	NWRP, Bhairahawa	Wheat	Bhrikuti	BS	98	0	10.8
0045	NWRP, Bhairahawa	Wheat	Gautam	BS	94	0	11.3
0046	NWRP, Bhairahawa	Wheat	NL 297	BS	96	0	11.6
0047	NWRP, Bhairahawa	Wheat	BL 4341	BS	96	0	8.8
0048	RARS, Khajura	Wheat	Banganga	BS	86	0	9.0
0049	RARS, Khajura	Wheat	Bhrikuti	BS	95	0	8.7
0050	RARS, Khajura	Wheat	NL 971	BS	93	0	8.6
0051	RARS, Khajura	Wheat	Bijaya	BS	86	0	8.8

Lab No	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)
0052	RARS, Khajura	Wheat	Gautam	BS	66	0	9.2
0053	Maize Storage Trial	Maize	Manakamana 3	FS	22	0	13.7
0054	Maize Storage Trial	Maize	Manakamana 3	FS	29	0	13
0055	Maize Storage Trial	Maize	Manakamana 3	FS	45	0	12.9
0056	Maize Storage Trial	Maize	Manakamana 3	FS	52	0	12.3
0057	Maize Storage Trial	Maize	Manakamana 3	FS	55	0	8.4
0058	Maize Storage Trial	Maize	Manakamana 3	FS	54	0	12.3
0059	Maize Storage Trial	Maize	Manakamana 3	FS	52	0	12.6
0060	Maize Storage Trial	Maize	Manakamana 3	FS	52	0	12.6
0061	Maize Storage Trial	Maize	Manakamana 3	FS	42	0	12.5
0062	Maize Storage Trial	Maize	Manakamana 3	FS	43	0	12.8
0063	Maize Storage Trial	Maize	Manakamana 3	FS	39	0	12.8
0064	Maize Storage Trial	Maize	Manakamana 3	FS	40	0	12.7
0065	Maize Storage Trial	Maize	Manakamana 3	FS	59	0	8.8
0066	Maize Storage Trial	Maize	Manakamana 3	FS	45	0	8.9
0067	Maize Storage Trial	Maize	Manakamana 3	FS	57	0	8.8
0068	Maize Storage Trial	Maize	Manakamana 3	FS	67	0	6.3
0069	Maize Storage Trial	Maize	Manakamana 3	FS	66	0	6.3
0070	Maize Storage Trial	Maize	Manakamana 3	FS	65	0	6.3
0071	Maize Storage Trial	Maize	Manakamana 3	FS	50	0	10.1
0072	Maize Storage Trial	Maize	Manakamana 3	FS	53	0	8.6
0073	Maize Storage Trial	Maize	Manakamana 3	FS	48	0	10.4
0074	NORP, Nawalpur	Sunflower	Sunflower	IS	28	0	0.0
0075	NORP, Nawalpur	Tori	Unnati	IS	98	0	0.0
0076	NJRP, Itahari	Maize	RML 4	FS	52	0	13.3
0077	NJRP, Itahari	Maize	RML 17	FS	79	0	13.8
0078-0098	Maize storage trial	Maize	Manakamana 3	FS	Recorded in Project Data Book		
0099-0145	Storage project O2/CO2/N2	Rice	Radha 4	FS	Recorded in Project Data Book		
0146	Bhakundebesi Krishi Sahakari Sanstha	Rice	Radha 4	IS	84	99.9	15.8
0147	SSTD, Khumaltar	Maize	Khumal Yellow	FS	100	0	0
0148	SSTD, Khumaltar	Maize	Khumal Yellow	FS	100	0	0
0149	SSTD, Khumaltar	Maize	Khumal Yellow	FS	96	0	0
0150	SSTD, Khumaltar	Maize	Khumal Yellow	FS	99	0	0
0151	Seed Coating Project	Maize	Khumal Yellow	FS	97	0	0
0152	Seed Coating Project	Maize	Khumal Yellow	FS	97	0	0
0153	Seed Coating Project	Maize	Khumal Yellow	FS	95	0	0
0154	Seed Coating Project	Maize	Khumal Yellow	FS	93	0	0
0155	Seed Coating Project	Maize	Khumal Yellow	FS	93	0	0
0156	Seed Coating Project	Maize	Khumal Yellow	FS	92	0	0
0157	Seed Coating Project	Maize	Khumal Yellow	FS	94	0	0
0158	Seed Coating Project	Maize	Khumal Yellow	FS	96	0	0
0159	Seed Coating Project	Maize	Khumal Yellow	FS	93	0	0
0160	Seed Coating Project	Maize	Khumal Yellow	FS	99	0	0
0161	Seed Coating Project	Maize	Khumal Yellow	FS	95	0	0
0162	Seed Coating Project	Maize	Khumal Yellow	FS	93	0	0
0163	Seed Coating Project	Maize	Khumal Yellow	FS	95	0	0
0164	Seed Coating Project	Maize	Khumal Yellow	FS	97	0	0
0165	Seed Coating Project	Maize	Khumal Yellow	FS	96	0	0
0166	Seed Coating Project	Maize	Khumal Yellow	FS	96	0	0

Lab No	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)
0167	Seed Coating Project	Maize	Khumal Yellow	FS	96	0	0
0168	Seed Coating Project	Maize	Khumal Yellow	FS	94	0	0
0169	Seed Coating Project	Maize	Khumal Yellow	FS	94	0	0
0170	Seed Coating Project	Maize	Khumal Yellow	FS	94	0	0
0171	RARS, Bara	Rice	Hardinath 1	FS	81	99.2	12
0172	RARS, Bara	Rice	Radha 4	FS	83	99.8	12.3
0173	RARS, Bara	Rice	Bahuguni dhan 2	FS	89	99.4	13.1
0174	RARS, Bara	Rice	Swarna sub 1	FS	81	99.5	13
0175	RARS, Bara	Rice	Hardinath 1	FS	81	99.8	13.7
0176	Seed Coating Project	Maize	Khumal Yellow	FS	96	0	0
0177	Seed Coating Project	Maize	Khumal Yellow	FS	93	0	0
0178	Seed Coating Project	Maize	Khumal Yellow	FS	94	0	0
0179	Seed Coating Project	Maize	Khumal Yellow	FS	95	0	0
0180	Seed Coating Project	Maize	Khumal Yellow	FS	95	0	0
0181	Seed Coating Project	Maize	Khumal Yellow	FS	95	0	0
0182	Seed Coating Project	Maize	Khumal Yellow	FS	98	0	0
0183	Seed Coating Project	Maize	Khumal Yellow	FS	93	0	0
0184	Seed Coating Project	Maize	Khumal Yellow	FS	97	0	0
0185	Seed Coating Project	Maize	Khumal Yellow	FS	96	0	0
0186	Seed Coating Project	Maize	Khumal Yellow	FS	96	0	0
0187	Seed Coating Project	Maize	Khumal Yellow	FS	97	0	0
0188	Seed Coating Project	Maize	Khumal Yellow	FS	92	0	0
0189	Seed Coating Project	Maize	Khumal Yellow	FS	97	0	0
0190	Seed Coating Project	Maize	Khumal Yellow	FS	98	0	0
0191	Seed Coating Project	Maize	Khumal Yellow	FS	97	0	0
0192	Dr. Tara Bahadur Ghimire	Maize	Deuti	FS	85	0	0
0193-0213	QPM maize storage trial	Maize	Manakamana 3	FS	Recorded in project data book		
0214-0229	Fingermillet project	Fingermillet	Various	FS	Recorded in project data book		

Annex 8.2. Service provided (routine sample), FY 2076/77 (2019/20)

Lab No.	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)	TGW (g)	Viable test	Remarks
0001	JJGBFPPNU, Dolakha	Oat	Parvati	IS	97	99.8	8.1	0	0	Lot 1
0002	NSPC, Godwari	Potato	HPS 7/67	HS	43	0	0.0	0	0	Lot 3
0003	NSPC, Godwari	Potato	HPS 7/67	HS	80	0	0.0	0	0	NSPC 1
0004	AD, Khumaltar	Wheat	Dhaulagiri	FS	88	0	8.6	0	0	Lot 1
0005	AD, Khumaltar	Wheat	Chyakhura	BS	92	0	9.3	0	0	Lot 2
0006	AD, Khumaltar	Wheat	Munal	BS	92	0	8.5	0	0	Lot 3
0007	AD, Khumaltar	Wheat	WK 1204	BS	92	0	8.1	0	0	Lot 4
0008	AD, Khumaltar	Wheat	Wk 1204	FS	91	0	8.1	0	0	Lot 5
0009	AD, Khumaltar	Wheat	Sworgdwari	FS	94	0	8.8	0	0	Lot 6
0010	AD, Khumaltar	Wheat	WK 1204	FS	90	0	8.8	0	0	Lot 7
0011	AD, Khumaltar	Wheat	Danphe	FS	84	0	7.9	0	0	Lot 8
0012	AD, Khumaltar	Wheat	Munal	FS	93	0	8.5	0	0	Lot 9
0013	AD, Khumaltar	Wheat	Chyakhura	FS	93	0	8.2	0	0	Lot 10
0014	DCDC, Dalchoki	Rapeseed	Gujmujje	IS	85	98.9	0.0	0	0	Lot 1
0015	DCDC, Dalchoki	Rapeseed	Dhude	IS	84	99.9	0.0	0	0	Lot 2
0016	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	0	0	11.3	0	0	J1R1
0017	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	0	0	11.6	0	0	J2R2
0018	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	95	0	11.1	0	0	P1R1
0019	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	0	0	11.3	0	0	P2R2
0020	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	92	0	10.9	0	0	G1R1
0021	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	94	0	10.6	0	0	G2R2
0022	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	92	0	10.2	0	0	PIC1R1
0023	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	92	0	10.3	0	0	PIC2R2
0024	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	93	0	10.2	0	0	SB1R1
0025	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	90	0	10.3	0	0	SB2R2
0026	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	0	0	12.3	0	0	J1R1
0027	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	0	0	12.1	0	0	J2R2
0028	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	0	0	12.9	0	0	P1R1
0029	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	0	0	12.7	0	0	P2R2

Lab No.	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)	TGW (g)	Viable test	Remarks
0030	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	97	0	10.4	0	0	G1R1
0031	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	90	0	10.0	0	0	G2R2
0032	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	94	0	9.4	0	0	PIC1R1
0033	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	94	0	9.5	0	0	PIC2R2
0034	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	85	0	10.2	0	0	SB1R1
0035	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	89	0	10.2	0	0	SB2R2
0036	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	0	0	12.4	0	0	J1R1
0037	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	14	0	11.9	0	0	J2R2
0038	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	6	0	11.9	0	0	P1R1
0039	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	30	0	11.7	0	0	P2R2
0040	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	10.5	0	0	G1R1
0041	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	93	0	10.2	0	0	G2R2
0042	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	90	0	9.8	0	0	PIC1R1
0043	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	94	0	10.0	0	0	PIC2R2
0044	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	91	0	11.0	0	0	SB1R1
0045	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	94	0	10.7	0	0	SB2R2
0046	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	88	0	10.3	0	0	Z1R1
0047	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	91	0	10.3	0	0	Z2R2
0048	NWRP, Bhairahawa	Rice	Radha 4	FS	1	0	12.1	0	0	J1R1
0049	NWRP, Bhairahawa	Rice	Radha 4	FS	27	0	11.9	0	0	J2R2
0050	NWRP, Bhairahawa	Rice	Radha 4	FS	1	0	12.1	0	0	P1R1
0051	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	12.0	0	0	P2R2
0052	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	8.9	0	0	G1R1
0053	NWRP, Bhairahawa	Rice	Radha 4	FS	1	0	9.0	0	0	G2R2
0054	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	9.1	0	0	PIC1R1
0055	NWRP, Bhairahawa	Rice	Radha 4	FS	71	0	9.0	0	0	PIC2R2
0056	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	9.8	0	0	SB3R3
0057	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	9.7	0	0	SB4R4
0058	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	8.4	0	0	J1R1
0059	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	8.2	0	0	J2R2
0060	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	11.1	0	0	P1R1

Lab No.	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)	TGW (g)	Viable test	Remarks
0061	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	10.8	0	0	P2R2
0062	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	11.7	0	0	G1R1
0063	NWRP, Bhairahawa	Rice	Radha 4	FS	3	0	11.5	0	0	G2R2
0064	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	11.9	0	0	PIC1R1
0065	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	11.9	0	0	PIC2R2
0066	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	12.5	0	0	SB1R1
0067	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	12.6	0	0	SB2R2
0068	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	11.4	0	0	J1R1
0069	NWRP, Bhairahawa	Rice	Radha 4	FS	5	0	11.6	0	0	J2R2
0070	NWRP, Bhairahawa	Rice	Radha 4	FS	3	0	12.1	0	0	P1R1
0071	NWRP, Bhairahawa	Rice	Radha 4	FS	2	0	11.7	0	0	P2R2
0072	NWRP, Bhairahawa	Rice	Radha 4	FS	48	0	12.7	0	0	G1R1
0073	NWRP, Bhairahawa	Rice	Radha 4	FS	1	0	11.8	0	0	G2R2
0074	NWRP, Bhairahawa	Rice	Radha 4	FS	1	0	11.9	0	0	PIC1R1
0075	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	12.3	0	0	PIC1R2
0076	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	12.8	0	0	SB1R1
0077	NWRP, Bhairahawa	Rice	Radha 4	FS	0	0	12.5	0	0	SB2R2
0078	NWRP, Bhairahawa	Rice	Radha 4	FS	50	0	10.8	0	0	Z1R1
0079	NWRP, Bhairahawa	Rice	Radha 4	FS	52	0	10.8	0	0	Z4R4
0080	Pramila Krishi Farm, Mulpani	Tomato	Srijana	HS	92	99.9	8.0	0	0	Wile-66
0081	HRS, Rajikot, Jumla	Rapeseed	Marpha	IS	93	100	3.8	0	0	Lot 1
0082	HRS, Rajikot, Jumla	Radhish	Tokinasi	IS	98	99.9	5.0	0	0	Lot 2
0083	HRS, Rajikot, Jumla	Carrot	New Karuda	IS	81	98.9	4.5	0	0	Lot 3
0084	HRS, Rajikot, Jumla	Swiss Chard	Susag	IS	95	99.1	5.0	0	0	Lot 4
0085	HRS, Rajikot, Jumla	Onion	Red creal	IS	57	99.4	7.0	0	0	Lot 5
0086	HRS, Rajikot, Jumla	Pea	Arkel	IS	97	100	10.4	0	0	Lot 6
0087	SKTPS & IPI, Dolakha	Potato (TPS)	HPS 7/67	HS	98	0	0	0	0	Lot 1
0088	S K S S Ltd, Bhaktapur	Wheat	WK 1204	CS	93	0	12.1	0	0	Krishne
0089	S K S S Ltd, Bhaktapur	Wheat	Swargadwari	CS	87	0	11.7	0	0	Punya
0090	S K S S Ltd, Bhaktapur	Wheat	WK 1204	CS	87	0	12.4	0	0	
0091	S K S S Ltd, Bhaktapur	Wheat	Sworgdwari	CS	91	0	13.5	0	0	Mahabir

Lab No.	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)	TGW (g)	Viable test	Remarks
0092	S K S S Ltd, Bhaktapur	Wheat	Swargadwari	CS	90	0	10.8	0	0	Tulshi
0093	S K S S Ltd, Bhaktapur	Wheat	Sworgdwari	CS	83	0	13.1	0	0	Surya
0094	NSPC, Godwari	Potato (TPS)	HPS 7/67 - 1	HS	84	0	0	0	0	Lot 1
0095	NSPC, Godwari	Potato (TPS)	HPS 7/67 - 2	HS	92	0	0	0	0	Lot 2
0096	NSPC, Godwari	Potato (TPS)	HPS 7/67 - 3	HS	85	0	0	0	0	Lot 3
0097	NSPC, Godwari	Potato (TPS)	HPS 7/67 - 4	HS	82	0	0	0	0	Lot 4
0098	NKSPSS Ltd, Dolakha	Wheat	Dhaulagiri	IS	93	0	10.6	0	0	Lot 1
0099	NKSPSS Ltd, Dolakha	Wheat	WK 1204	IS	93	0	10.7	0	0	Lot 2
0100	NKSPSS Ltd, Dolakha	Wheat	Swargadwari	IS	90	0	10.9	0	0	Lot 3
0101	NKSPSS Ltd, Dolakha	Wheat	WK 2223	IS	98	0	10.9	0	0	Lot 4
0102	RARS, Bara	Wheat	Gautam	FS	90	100	10.3	0	0	Lot 1
0103	RARS, Bara	Wheat	Bijaya	FS	96	99.5	10.3	0	0	Lot 2
0104	RARS, Bara	Wheat	Aditya	FS	89	100	10.4	0	0	Lot 3
0105	RARS, Bara	Wheat	NL 971	FS	95	99.9	10.3	0	0	Lot 4
0106	RARS, Bara	Rapeseed	Pragati	FS	96	98.5	5	0	0	Lot 5
0107	RARS, Bara	Lentil	Simal	FS	94	98.9	10.5	0	0	Lot 6
0108	RARS, Bara	Lentil	Sindur	FS	93	99	9.9	0	0	Lot 7
0109	RARS, Bara	Lentil	Sital	FS	97	99.3	9.5	0	0	Lot 8
0110	ARS, Belachapi, Dhanusha	Wheat	Gautam	FS	91	99.9	11	0	0	Lot 1
0111	ARS, Belachapi, Dhanusha	Wheat	Bijaya	FS	86	99.6	11.1	0	0	Lot 2
0112	SQCC, Hariharbhawan	Wheat	Dhaulagiri	PS	73	98.9	0	0	0	PS Lot 1
0113	SQCC, Hariharbhawan	Wheat	Swargadwari	PS	97	99.9	0	0	0	PS Lot 2
0114	SQCC, Hariharbhawan	Wheat	WK 1204	PS	92	99.9	0	0	0	PS Lot 3
0115	SKTPS & IPI, Dolakha	Potato (TPS)	TPS (1)	HS	73	0	0	0	0	Lot 4
0116	SKTPS & IPI, Dolakha	Potato (TPS)	TPS (2)	HS	80	0	0	0	0	Lot 5
0117	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	9.9	0	0	PICS R1
0118	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	9.4	0	0	PICS R2
0119	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	98	0	10.9	0	0	SB1R1
0120	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	95	0	11.4	0	0	SB1R2
0121	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	93	0	12.3	0	0	G1R1
0122	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	11.1	0	0	G1R2

Lab No.	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)	TGW (g)	Viable test	Remarks
0123	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	9.7	0	0	PICS R1
0124	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	9.6	0	0	PICS R2
0125	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	95	0	11.4	0	0	SB1R1
0126	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	95	0	11.9	0	0	SB1R2
0127	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	97	0	10.9	0	0	G1R1
0128	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	94	0	10.7	0	0	G1R2
0129	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	97	0	9	0	0	PICS R1
0130	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	9.1	0	0	PICS R2
0131	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	10.7	0	0	SB1R1
0132	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	10.7	0	0	SB1R2
0133	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	94	0	10.5	0	0	G1R1
0134	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	97	0	10	0	0	G1R2
0135	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	96	0	9.4	0	0	Zeolite R1
0136	NWRP, Bhairahawa	Wheat	Bhrikuti	FS	95	0	9.6	0	0	Zeolite R2
0137	BKBBSS Ltd	Rice	Khumal 4	IS	84	99	14.7	0	0	Lot 1
0138	NKSPSS Ltd, Dolakha	Maize	Rampur Composite	IS	92	0	13.4	0	0	Lot 1
0139	NKSPSS Ltd, Dolakha	Maize	Ganesh 1	IS	96	0	13.4	0	0	Lot 2
0140	NKSPSS Ltd, Dolakha	Maize	Manakamana 3	IS	98	0	14.1	0	0	Lot 3
0141	NKSPSS Ltd, Dolakha	Maize	Arun 2	IS	84	0	11.7	0	0	Lot 4
0142	AD, Khumaltar	Rice	Khumal 4	FS	92	99.9	11.3	0	0	Lot 1
0143	AD, Khumaltar	Rice	Khumal 4	FS	94	99.9	11.4	0	0	Lot 2
0144	AD, Khumaltar	Rice	Khumal 10	FS	96	99.9	11.1	0	0	Lot 3
0145	AD, Khumaltar	Rice	Khumal 10	FS	96	99.6	11.2	0	0	Lot 4
0146	AD, Khumaltar	Rice	Chainung 242	FS	92	99.8	11.2	0	0	Lot 5
0147	AD, Khumaltar	Rice	Khumal 11	FS	91	99.9	11.7	0	0	Lot 6
0148	AD, Khumaltar	Rice	Khumal 8	FS	90	99.8	10.9	0	0	Lot 7
0149	AD, Khumaltar	Rice	08 FAN 10	FS	89	99.8	11.5	0	0	Lot 8
0150	BKBBSS Ltd.	Rice	Khumal 11	IS	88	99.7	13.1	0	0	Lot 1
0151	BKBBSS Ltd.	Rice	Khumal 10	IS	93	99	14.4	0	0	Lot 2
0152	ABD, Khumaltar	Maize	Manakamana 4	FS	97	0	0	0	0	Lot 1
0153	ABD, Khumaltar	Maize	Manakamana 4	FS	98	0	0	0	0	Lot 2

Lab No.	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)	TGW (g)	Viable test	Remarks
0154	ABD,Khumaltar	Maize	Manakamana 4	FS	96	0	0	0	0	Lot 3
0155	ABD,Khumaltar	Maize	Khumal Hybrid 2	HS	98	0	0	0	0	Lot 4
0156	ABD,Khumaltar	Maize	LPM 153	HS	94	0	0	0	0	Lot 5
0157	ABD,Khumaltar	Maize	LPM 164	HS	76	0	0	0	0	Lot 6
0158	ABD,Khumaltar	Maize	LPM 162	HS	25	0	0	0	0	Lot 7
0159	ABD,Khumaltar	Maize	Deuti	FS	71	0	0	0	0	Lot 8
0160	ABD,Khumaltar	Maize	Manakamana 7	FS	99	0	0	0	0	Lot 9
0161	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	84	99.7	14.6	0	0	A1
0162	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	84	100	13.2	0	0	A2
0163	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	78	100	13.7	0	0	A3
0164	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	90	99.4	14.2	0	0	A4
0165	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	84	100	13	0	0	A3-1
0166	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	89	99.9	14.2	0	0	A5
0167	ABD,Khumaltar	Soybean	Ransom	FS	98	0	0	0	0	Lot 1
0168	ABD,Khumaltar	Soybean	Sathiya B	FS	81	0	0	0	0	Lot 2
0169	ABD,Khumaltar	Soybean	Changmau B	FS	98	0	0	0	0	Lot 3
0170	ABD,Khumaltar	Rice	Khumal 4	FS	98	99.4	0	0	0	Lot 4
0171	ABD,Khumaltar	Rice	Khumal 8	FS	96	99.6	0	0	0	Lot 5
0172	ABD,Khumaltar	Rice	Khumal 10	FS	98	99.8	0	0	0	Lot 6
0173	ABD,Khumaltar	Rice	Khumal 11	FS	96	98.6	0	0	0	Lot 7
0174	ABD,Khumaltar	Rice	Chainung 242	FS	92	98.9	0	0	0	Lot 8
0175	ABD,Khumaltar	Rice	08 FAN 10	FS	97	98.6	0	0	0	Lot 9
0176	NKSS Ltd, Siddhipur	Rice	Taichung	IS	94	99.9	12.9	0	0	Shyam
0177	NKSS Ltd, Siddhipur	Rice	Taichung	IS	91	99.9	13.4	0	0	Parbati
0178	NKSS Ltd, Siddhipur	Rice	Taichung	FS	96	99.9	13.5	0	0	Saraswoti
0179	NKSS Ltd, Siddhipur	Rice	Taichung	IS	94	100	13.7	0	0	Ram Kri
0180	NKSS Ltd, Siddhipur	Rice	Taichung	FS	98	99.6	11.8	0	0	Dipendra
0181	NKSS Ltd, Siddhipur	Rice	Khumal 11	IS	97	100	11.3	0	0	Gyani
0182	NKSS Ltd, Siddhipur	Rice	Chainung 242	FS	97	100	11.4	0	0	Gyani
0183	NKSS Ltd, Siddhipur	Rice	Taichung	FS	95	99.8	13.4	0	0	Ratna
0184	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	78	99.5	12.2	0	0	Narayan

Lab No.	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)	TGW (g)	Viable test	Remarks
0185	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	89	99.4	12.5	0	0	Suman
0186	SKSS Ltd, Bhaktapur	Rice	Chainung 242	IS	85	98	11.5	0	0	Sangita
0187	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	90	99.5	13.4	0	0	Srijana
0188	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	90	99.9	13.2	0	0	Sushila
0189	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	93	99.9	11.3	0	0	TikaRam
0190	SKSS Ltd, Bhaktapur	Rice	Khumal 10	IS	94	99.3	10.9	0	0	Sangi
0191	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	90	99.1	11.9	0	0	Nawaraj
0192	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	93	99.6	12.3	0	0	Arjun
0193	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	96	99.4	12.8	0	0	Shree Ram
0194	AD, Khumaltar	Soybean	Tarkari Bhatmas	FS	86	0	9.7	0	0	Lot 1
0195	SKSS Ltd, Bhaktapur	Rice	Khumal 10	IS	96	99.9	14.3	0	0	Sankar
0196	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	89	99.2	15.4	0	0	Sankar
0197	SKSS Ltd, Bhaktapur	Rice	Khumal 11	IS	95	99.8	13	0	0	Niru
0198	SKSS Ltd, Bhaktapur	Rice	Khumal 10	IS	94	99.9	12.8	0	0	Punesh
0199	NWRP, Bhairahawa	Rice	Radha 4	FS	88	0	13.4	0	92	Bimiha
0200	NWRP, Bhairahawa	Rice	Radha 4	FS	89	0	13.3	0	95	Bhagdari
0201	NWRP, Bhairahawa	Rice	Radha 4	FS	88	0	13.3	0	95	
0202	DoLS, Hariharbhawan	Oats	Amritdhara	FS	63	98.9	9.6	19.8	0	NSLot 1
0203	DoLS, Hariharbhawan	Naked Oat	NZA 3/13	FS	80	97.9	11.7	19.6	0	NSLot 2
0204	DoLS, Hariharbhawan	Naked Oat	NZA 3/22	FS	90	97.4	10	18.2	0	NSLot 3
0205	DoLS, Hariharbhawan	Naked Oat	NZA 3/33	FS	80	95.5	11.3	19.9	0	NSLot 4
0206	DoLS, Hariharbhawan	Naked Oat	NZA 3/40	FS	76	95.9	11.6	20.9	0	NSLot 5
0207	DoLS, Hariharbhawan	Wheat	Local Wheat	FS	82	98.9	10.5	44.4	0	NS Lot 6
0208	DoLS, Hariharbhawan	Wheat	Wintermax	FS	96	98.7	9.3	30.7	0	NSLot 7
0209	DoLS, Hariharbhawan	Wheat	Crack Jack	FS	92	94.5	8.7	23.7	0	NS Lot 8
0210	DoLS, Hariharbhawan	Wheat	Bolt	FS	80	94	10.3	28.8	0	NSLot 9
0211	DoLS, Hariharbhawan	Oat	Amritdhara	FS	71	99.1	12.2	25	0	RSLot 10
0212	DoLS, Hariharbhawan	Naked Oat	NZA 3/13	FS	70	91.8	12.6	21.9	0	RS Lot 11
0213	DoLS, Hariharbhawan	Naked Oat	NZA 3/22	FS	73	95.2	12.6	19.6	0	RS Lot 12
0214	DoLS, Hariharbhawan	Naked Oat	NZA 3/33	FS	72	90.8	11.2	21	0	RS Lot 13
0215	DoLS, Hariharbhawan	Naked Oat	NZA 3/40	FS	78	94.2	11.6	20.3	0	RS Lot 14

Lab No.	Name and Address	Crop	Variety	Seed Class	Germination (%)	Purity (%)	Moisture (%)	TGW (g)	Viable test	Remarks
0216	DoLS, Hariharbhawan	Wheat	Local Wheat	FS	87	99.3	11.8	45.6	0	RS Lot 15
0217	DoLS, Hariharbhawan	Wheat	Wintermax	FS	77	99	12.2	35.4	0	RS Lot 16
0218	DoLS, Hariharbhawan	Wheat	Crack Jack	FS	42	94.5	12	35	0	RSL17
0219	DoLS, Hariharbhawan	Wheat	Bolt	FS	47	93.5	12	31.7	0	RS Lot 18

Note: DoLS=Department of Livestock Services, JJGBFPPNU=Jana Jyoti Ghas Bue Falfull Pashu Palan Nursary Udyog, NSPC=Nepal Seed Production Center, AD=Agronomy Division, DCDC=Dalchoki Community Development Committee, NWRP=National Wheat Research Programme, PKF=Pramila Krishi Farm, HRS=Horticulture Research Station, SKTPS& IPI=Shree Kalinchowk TPS & Improved Seed Production Industry, SKSS Ltd.=Siddhi Krishi Sahakari Sanstha Limited, NKSPSS Ltd=Naldhunga Krishi and Seed Production Sahakari Sanstha Limited, RARS=Regional Agricultural Research Station, ARS=Agricultural Research Station, ABD=Agriculture Botany Division, SQCC=Seed Quality Control Centre, RS=Ranjitpur Sample, Nepalgunj sample, PS=Proficiency Sample, BS=Breeder Seed, SKSS Ltd= Siddhi Krishi Sahakari Sanstha Limited, Bhaktapur, FS=Foundation Seed, CS=Certified Seed, IS=Improved Seed, HS=Hybrid Seed.

Annex 9 Publications in FY 2076/77(2019/20)

SN.	Name of publications	Type *	Language	Authors	No. of copies
1	Annual Report (2076/77)	Book	English	NSSTRC	100
2	Seed Science & Technology Division - A Brief Profile	Leaflet	English	SSTD	1000
3	बीउ विज्ञान प्रविधि महाशाखा – एक संक्षिप्त परिचय	Leaflet	Nepali	SSTD	1000

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

Annex 10 Visit of the office by farmers, extension officials /technicians, entrepreneurs, cooperatives, farmer groups, NGO/CBO officials etc.

S.No.	Leader's name	Students Number	Area of Major Interest
1	Mrs. Pallabi Singh	48	Visited seed testing laboratory. Technical information about seed quality testing services.
2	Mrs. Pallabi Singh	48	HICAST students visited seed lab. They were interested to know the technical information about seed quality testing services.
3	Pramila Krishi Farm	8	JTA students visited seed lab and experimental field. Technical information about seed quality testing services.
4	Dr. Krishna Tumahar	50	Lab visit and field exposure. Technical information about seed quality testing services
5	Mr. Dilli K.C	13	NIMS students lab visit. Technical information about seed quality testing services
6	Dhuralsaini Ma.Vi.	25	Students lab visit and field exposure. Technical information about seed quality testing services

Annex 11 Work experience programme (WEP), internship and volunteers etc. in FY 2076/77 (2019/20)

S.No.	College/ Institutions	Level	Number	Duration (Days)
1	Shree Saraswoti Secondary School	T-See	1	88
2	Amritsar College of Engineering and Technology	B.Sc.Ag	1	14
3	Phonics Group of Institute	B.Sc.Ag	1	118
4	Singh Acadamy	TSLC	5	178
5	Shree Tribhuwan High Secondary School	TSLC	1	124
6	Shree Sarba Secondary School, Dolakha	I.Sc. Ag	3	22
7	Shree Bhairab Navadeep Secondary School, Palpa	I.Sc. Ag	2	9
8	Sumnima Polytechnic Institute, Bhojpur	I.Sc. Ag	2	6
9	Training Institute for Technical Instructon	officer	2	4
	Total		**18**	

Annex 12 नियमित तर्फको वार्षिक बजेट र खर्चको विवरण आ.व २०७६/७७ (२०१९/२०)

बजेट शिर्षक: ३१२१३६३ चालु खर्च

शिर्षक	उपशिर्षक	वार्षिक बजेट	वार्षिक खर्च	बाकिं बजेट
२१११११	पारिश्रमिक कर्मचारी	५,३००,०००.००	४,६२५,९७७.००	६७४,०२३.००
२११२१	पोशाक	११०,०००.००	९०,०००.००	२०,०००.००
२११३२	महंगी भत्ता	२६४,०००.००	२२२,०००.००	४२,०००.००
२१२१३	योगदानमा आधारित बिमा कोष खर्च	५३,०००.००	४४४००.००	८६००.००
२२१११	पानी तथा विजुली महशुल	१००,०००.००	४९,१६२.००	५०,८३८.००
२२११२	संचार महशुल	११८,०००.००	११८,०००.००	०.००
२२२११	ईन्धन (कार्यालय प्रयोजन)	३५३,०००.००	३५३,०००.००	०.००
२२२१३	सवारी साधन मर्मत खर्च	२६०,०००.००	२५९,९९८.००	२.००
२२२१४	बिमा तथा नविकरण खर्च	३६,०००.००	२६,०४८.००	९,९५२.००
२२२२१	मेशिनरी तथा औजार मर्मत संभार तथा संचालन खर्च	४१०,०००.००	४०९,९८९.००	११.००
२२२३१	निर्मित सार्वजनिक सम्पत्तिको मर्मत संभार खर्च	१००,०००	९७,९५७.००	२,०४३.००
२२२९१	अन्य सम्पत्तिहरुको संचालन तथा संभार खर्च	४०,०००.००	३९,९००.००	१००.००
२२३११	मसलन्द तथा कार्यालय सामाग्रि	२५०,००.००	२४९,९२१.००	७९.००
२२३१४	ईन्धन–अन्य प्रयोजन	५००००.००	५०,०००.००	०.००
२२३१५	पत्र पत्रिका, छपाई तथा सुचना प्रकाशन खर्च	२००,०००.००	१,९९,९०८.००	९२.००
२२४१३	करार सेवा शुल्क	६०,०००	०.००	६०,०००.००
२२५२१	उत्पादन सामाग्री/सेवा खर्च	३५,३२,०००.००	३,३६,५४९.१४	१,७०,४५१.००
२२६११	अनुगमन, मूल्याङ्कन खर्च	२,४०,०००.००	९९,५००.००	१,४०,५००.००
२२६१२	भ्रमण खर्च	७,२०,०००.००	५,११,१२८.००	२,०८,८७२.००
२२७११	विविध खर्च	९०,०००.००	७८,१८८.००	११,८१२.००
	कुल जम्मा	**१२,२८६,०००.००**	**१०,८८६,६२५.००**	**१,३९९,३७५.००**

बजेट शिर्षक: ३१२१३६४ पुंजिगत खर्च

शिर्षक	उपशिर्षक	वार्षिक बजेट	वार्षिक खर्च	बाकिं बजेट
२३१२१	सवारी साधन	२,५०,०००.००	२,४९,९००.००	१००.००
३११२२	मेशिनरी औजार	८,४०,०००.००	७,९५,४४८.००	४४,५५२.००
	कुल जम्मा	**१,०९०,०००.००**	**१,०४५,३४८.००**	**४४,६५२.००**

Annex 13 राजस्व विवरण आ.व २०७५/७६ (२०१९/२०)

आम्दानीको श्रोत	जम्मा रकम (रु.)	कैफियत
बाली तथा बागवानी अनुसन्धान	१,२४,५७५.००	सेवा नमूना र अनुसन्धान नमूना परिक्षण बाट प्राप्त भएको
बाली तथा बागबानी उत्पादन	३१,२७१.००	विभिन्न परिक्षण बाट उत्पादन र सुरक्षा नमूना बिक्री बाट प्राप्त भएको
प्रशासनिक आम्दानी	११,०००.००	विभिन्न प्रशासनिक कार्यहरुबाट प्राप्त भएको
कुल जम्मा	**१,६६,८४६.००**	

Annex 14 बेरुजुको विवरण आ.व २०७५/७६ (२०१९/२०)

आर्थिक वर्ष	बेरुजु रकम (रु.)	कैफियत
आ.व. २०७४/७५ देखि २०७५/७६ सम्म	८४,२२५.००	फछ्यौटको प्रकृयामा रहेको